Appendix A

BaselineGreen™ Report

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A1.0 Objectives

A BaselineGreen™ analysis of new construction in the Seattle metropolitan three-county region of three building types - office, commercial, and residential - was performed in order to:

a) examine the upstream (i.e., supply chain) external environmental burdens associated with the manufacture of all identifiable material and product inputs to construction of the three building types,

b) investigate how these burdens may adversely affect salmon habitats, and

c) propose design and construction guidelines for avoiding or minimizing upstream environmental burdens that directly or indirectly affect salmon habitat.

The main objective of the analysis is to aid the City of Seattle in identifying "salmon friendly" building methods and practices in the City's effort to preserve, restore, and protect the many salmon habitats along its urban shorelines and in its many rivers, lakes, streams, and man-made waterways. The design and construction of "salmon friendly" buildings is one of a variety of strategies being pursued by the City of Seattle to achieve the goal of restoring and protecting sustainable, healthy salmon habitats throughout the Puget Sound region.

A2.0 Background

A2.1 Environmental Factors Contributing to Salmon Habitat Loss

Habitat loss and degradation has been identified as the major environmental cause of declining salmon populations in the Northwest. Environmental factors contributing to habitat loss and degradation may be roughly divided between historical modifications to shorelines, rivers, and streams and continuing or on-going activities or conditions affecting ecosystems that support salmon.

Historical modifications to Seattle's watersheds during the past century include physical alterations to the environment for the purposes of natural resource extraction, navigation, transportation accessibility, flood control, water supply, and land creation. The consequent landscape-scale land use and land cover changes profoundly affected salmon habitats. The negative impacts include loss of estuaries, loss of access to habitats, forced diversions in migration routes, urbanization of shorelines and stream and river banks, and major alterations to the hydrology of rivers and streams that support fish. These modifications, although related to building design and construction on a large scale, are better addressed as urban or regional planning issues. It is important to acknowledge these factors as many continue to adversely affect salmon populations, but they lie outside the scope of this BaselineGreen™ analysis.

The BaselineGreen™ analysis addresses some of the continuing biochemical environmental stressors to salmon habitat associated with building design and construction. Human-induced environmental (i.e., non-predator/competitor and non-natural event) factors contributing to habitat loss and degradation in all types of habitat – freshwater, estuary, and saline water – can be sorted into two broad categories: water quality and water quantity/rate of flow. The major environmental factors in each of these two categories are summarized in Table A2.1.1.

Previous research by others has investigated how the environmental factors affecting salmon habitat may vary for each geographic area or watershed in the Seattle region. In Table A2.1.2 on the following page, for each of five identifiable geographic areas in Seattle, the factors that do and do not play a role in significantly contributing to salmon habitat loss are summarized.

Common to all five geographic areas in the City of Seattle is the fact that toxic releases, both spills from point sources and discharges from non-point sources, can occur with significant impact to salmon habitats. The impact of a toxic spill or discharge on salmon habitat would depend on the concentration of the substance, its properties and persistence, the rate and total volume of the discharge, the area of habitat affected by the spill, and the time of year the spill occurred. While toxic releases to water may have occurred in the past, they have been significantly reduced over the past two decades due to state and federal clean water regulations (see section 4 below).

Urban streams appear to have the most exposure and highest susceptibility to all environmental factors affecting salmon habitat. The quantity of water in Seattle's urban

Table A2.1.1: Summary of Environmental Factors Contributing to Salmon Habitat Loss and Degradation

Water Quality	Water Quantity/Flow
Toxic releases and sediment contamination	Too much water (stormwater runoff)
Erosion, sedimentation, and turbidity	Too little water
Water temperature fluctuations	Barriers, channels, and diversions

Source: "Factors Affecting Chinook Populations, Background Report" prepared for the City of Seattle by Parametrix Inc., Natural Resources Consultants, Inc., and Cedar River Associates, June 2000.

streams is greatly affected by a lack of stormwater retention in the drainage basins. Resulting environmental impacts include alternate flooding and dry periods, sedimentation, scouring, and low summer base flows. In addition, water quality in small streams is affected by stormwater runoff. Earlier studies have indicated the presence of hundreds of chemical compounds from streets, highways, and other developed urban areas. Several non-point sources were identified including automobiles, leaking septic fields, and household fertilizer use.

Large bodies of water such as Lake Washington and the Puget Sound shoreline apparently have the least susceptibility to many of the environmental factors listed above. The relatively large volume of water in these salmon environments makes them more resilient to short term environmental stresses than small rivers and urban streams. For example, stormwater runoff may temporarily impact a localized area of a lake or shoreline, but the (typically) short duration and dilution of the runoff will likely limit the negative effect on salmon habitat in proximity to the runoff event.

Outside the City of Seattle, and especially in the two surrounding watersheds (the Cedar/Sammamish and the Green/Duwamish), all of the environmental factors listed in Table A2.1.1 play a role in contributing to salmon habitat loss and degradation. Factors affecting water quality include the presence of contaminants and/or pollutants in some tributaries, sedimentation, and increasing water temperatures (apparently weather induced). Factors affecting water quantity/flow include high and low water level problems associated with uncontrolled stormwater runoff and a large number of flood control structures and diversions that are barriers to salmon migration.

Table A2.1.2: Likelihood of Environmental Factors Contributing to Salmon Habitat Loss and Degradation Occurring in Each of Five Seattle Geographic Areas

Geographic Area	Factors that Likely Do Have Significan Impact in the Area	Factors that Likely Do Not Have Significant Impact in the Area
Lake Washington	• Toxic releases (spills or large scale discharges such as from pesticides)	• Toxic discharges from stormwater runoff • Water temperature changes from stormwater runoff • Too much water - stormwater runoff • Barriers, channels, diversions
Lake Union System	• Toxic releases • Sediment contamination (historical) • Water temperature fluctuations (climatic causes) • Barriers, channels, and diversions (locks, ship canal, bulkheads)	• Toxic discharges from stormwater runoff • Water temperature changes from stormwater runoff • Too much water - stormwater runoff
Duwamish River and Elliot Bay	• Toxic releases • Sediment contamination (historical)	• Toxic discharges from stormwater runoff • Water temperature changes from stormwater runoff • Too much water - stormwater runoff • Barriers, channels, diversions
Puget Sound Shorelines	• Toxic releases • Barriers, channels, and diversions (piers, bulkheads)	• Toxic discharges from stormwater runoff • Water temperature changes from stormwater runoff • Too much water - stormwater runoff
Urban Streams	• Toxic releases • Toxic discharges from stormwater runoff • Erosion, sedimentation, and turbidity • Water temperature changes from stormwater runoff • Too much water - stormwater runoff • Too little water - lack of stormwater retention • Barriers, channels, diversions	

Source: "Factors Affecting Chinook Populations, Background Report" prepared for the City of Seattle by Parametrix Inc., Natural Resources Consultants, Inc., and Cedar River Associates, 06/2000.

The scope of the BaselineGreen™ analysis is much narrower than the diverse origins of the many environmental factors discussed above (see Tables A2.1.3 and A2.1.4 below). Its focus is on the upstream supply chain, or bill of material inputs to building design and construction. It examines three upstream environmental burdens associated with these inputs - toxic releases, air pollutants, and greenhouse gases – using available national and state data for industrial facilities (point sources) that annually report toxic releases to water, land, and air and criteria air pollutants. This data is used to portray the typical toxic release inventory and air pollution history of several different industry groups. (See Methodology section below.)

Toxic releases to water have a direct and significant impact on water quality. Toxic releases to land (or in underground storage) can seep into ground water sources and aquifers and eventually enter lakes, rivers, and streams. Toxic releases to air and criteria air pollutants can return to land and bodies of water through the process of atmospheric deposition. Greenhouse gas emissions can contribute to global warming and subsequently contribute to increases in water temperature and perhaps water level fluctuations.

Table 2.1.3: Building and Urban Development Associated Environmental Burdens Detrimental to Water Quality Sorted by Origin
(Shaded cells indicate scope of work of the BaselineGreen™ analysis.)

	Environmental Factor	Building and Development Related Issue	Industrial Facility/ IndustryGroup	Urban Scale	Watershed / Regional Scale	State Scale	National Scale	International Scale
Water Quality (Freshwater, Estuary, and Saline Habitats)	Toxic Release Contamination	Toxic releases to water	√	√	√			
		Toxic releases to land/underground	√	√	√			
		Toxic releases to air	√	√	√			
		Air pollutants	√	√	√			
	Water Temperature Changes	Greenhouse gases	√	√	√			
		Impervious cover		√	√			
		Land use and land cover changes		√	√	√	√	√
	Erosion, Sedimentation and Turbidity	Impervious cover		√	√			
		Land use and land cover changes		√	√	√	√	√
		Logging and mining			√	√	√	√

Table 2.1.4: Building and Urban Development Associated Environmental Burdens Detrimental to Water Quantity Sorted by Origin
(None of these building and development issues is included in the BaselineGreen™ analysis.)

	Environmental Factor	Building and Development Related Issue	Industrial Facility/ Industry Group	Urban Scale	Watershed / Regional Scale	State Scale	National Scale	International Scale
Water Quantity and Flow (Primarily Freshwater and Estuary Habitats)	Too Much Water	Impervious Cover		√	√			
		Dredging, Filling Channelization		√	√			
		Land Use/Land Cover Changes		√	√	√	√	√
		Logging And Mining			√	√	√	√
		Channels and dams	√	√	√			
	Too Little Water	Municipal, Industrial, Agricultural Use	√	√	√			
		Lack of retention	√	√	√			
	Barriers and Diversions	Land Use/Land Cover Changes		√	√	√	√	√
		Dams	√	√	√			

Erosion, sediment deposition, and turbidity can be a result of logging and quarrying activities. The BaselineGreen™ analysis does not attempt to examine these links. Additionally, as stated above, urban development modifications to shorelines, rivers and streams – impervious cover, barriers, channels and dams – are not within the scope of this work.

Table A2.1.3 on the previous page indicates the scale of *origin* of environmental factors affecting **water quality**. The shaded cells in Table A2.1.3 indicate the scope of work of the BaselineGreen™ analysis relative to all of the environmental factors described above. BaselineGreen™ focuses on environmental burdens that originate upstream from manufacturing inputs to buildings. These manufacturing inputs are usually industry groups that can be broken down into identifiable "point source" industrial facilities.

Table A2.1.4 on the previous page indicates the scale of origin of environmental factors affecting **water quantity**. BaselineGreen™ does not address any environmental factors affecting water quantity.

In each table a check indicates an environmental impact to salmon habitat and the scale at which the impact typically originates. Some are more local impacts such as point source toxic releases to water, some are more state and national in scale such as logging, and some are both such as air pollutants. Toxic releases, air pollutants, and greenhouse gases become urban, regional, and even statewide problems when automobile and truck modes of transportation of goods and services are included. Land use and land cover changes, as well as logging and mining activities, can become national and even international in scale when the watersheds in which the activities are located cross state and national political boundaries (e.g., Washington and British Columbia).

A2.2 Prioritizing Environmental Factors Contributing to Salmon Habitat Loss

Within the scope of the BaselineGreen™ analysis, the upstream building-related environmental burdens linked to the above factors were prioritized from most direct to least direct impact on salmon habitat as follows:

- Most direct: Toxic releases to water,
- Toxic releases to land/underground,
- Toxic releases to air,
- Criteria air pollutants,
- Least direct: Greenhouse gases.

As mentioned above, the direct link between toxic releases to water or land and water quality is self-evident. Toxic releases to air and criteria air pollutants are less direct factors since the process of atmospheric deposition must occur to accrue airborne toxics and pollutants on land or in bodies of water. Atmospheric deposition also disperses and dilutes toxics and pollutants over a widespread area. Most of the State of Washington is rated as having low to moderate susceptibility to the process and documented levels of many pollutant indicators have not increased over the past 20 to 30 years.

Although greenhouse gas emissions can lead to global warming, they are considered to be the least direct environmental factor since many steps and processes are involved in their connection to increased surface water temperatures. Moreover, many other factors contribute to climate changes that influence increasing air and water temperatures such as non-point source pollution (automobiles), urban heat islands, and vegetative cover.

Outside the scope of the BaselineGreen™ analysis, other urban and regional scale building and development activities are linked to the environmental factors contributing to salmon habitat loss and degradation. These include the following:

- Logging and quarrying activities,
- Transportation issues,
- Percent of impervious cover,
- Land use and land cover changes,
- Changes to and loss of wetlands,
- Dredging, filling, and channelization of rivers and streams,
- Diversions and dams,
- Municipal, industrial, and agricultural water use.

A2.3 Upstream Environmental Impacts Relative to Full Building Life Cycle

Upstream environmental burdens associated with building construction should be put in context relative to the environmental burdens that occur over a building's entire life cycle. In terms of prioritizing municipal policies or actions that may have the most significant effect in minimizing or eliminating these burdens, it would be helpful to know whether or not the upstream burdens are more, less or equal to burdens associated with other stages of a building's life cycle - the use phase (building occupancy) or post-use phase.

In the case of toxic releases, upstream environmental burdens associated with building materials and products likely represent a majority of the toxic releases associated with the full life cycle of a building (Figure A2.3.1 on the following page). This is due to the fact that many industries typically use several chemicals and substances classified as toxic in processing materials and products. Many of these are not included in the content of the final material or product but are used as processing agents. Although many of these chemicals and substances are recycled within the facility for reuse, the toxic release data indicates that large quantities are discharged as air emissions and similar amounts are typically transferred off-site to landfills or recycling operations.

In the case of air pollutants and greenhouse gases, the upstream life cycle stage represents a small portion of total burdens associated with full building life cycle. For example, in the case of the Seattle Justice Center (SJC) project, it was estimated that upstream burdens were equivalent to approximately 5-10 years of operation of a typical office/commercial mixed-use building. This is due to the fact that the energy consumption over the useful life of a typical office/commercial building generates a greater amount of air pollution and greenhouse gases emissions due to fossil fuel combustion in the generation of purchased electrical power. This is also due to the

fact that, as the building is maintained and modified over time, environmental burdens associated with maintenance and remodeling activities also accumulate. In the case of air pollution and greenhouse gases therefore, purchasing electricity for the building from "salmon friendly" power sources may also be a significant factor to address as well as upstream toxic release burdens.

Thus it appears that upstream supply chain activities are the life cycle stage of a building when toxic releases are most significant. Air pollutants and greenhouse gases are relatively less significant upstream and relatively more significant during a building's use or occupancy stage.

A2.4 Upstream Environmental Impacts Relative to Annual Value of Construction of Different Building Types

Upstream environmental burdens associated with building construction should also be put in context relative to the volume or economic value of different building types constructed in the region. When prioritizing municipal policies or actions that may have the most significant effect in minimizing or eliminating these burdens, it would be helpful to know which building type or types has the greatest environmental impact – residential, office, or commercial.

One way of estimating the relative environmental burdens of each of the three building types is to review annual building permit data. This data includes the number of building permits issued, the building use definition (by code) for each permit, and the estimated construction cost of each project. Since the BaselineGreen™ methodology (see Section A3 below) links environmental burdens to the economic activity of an

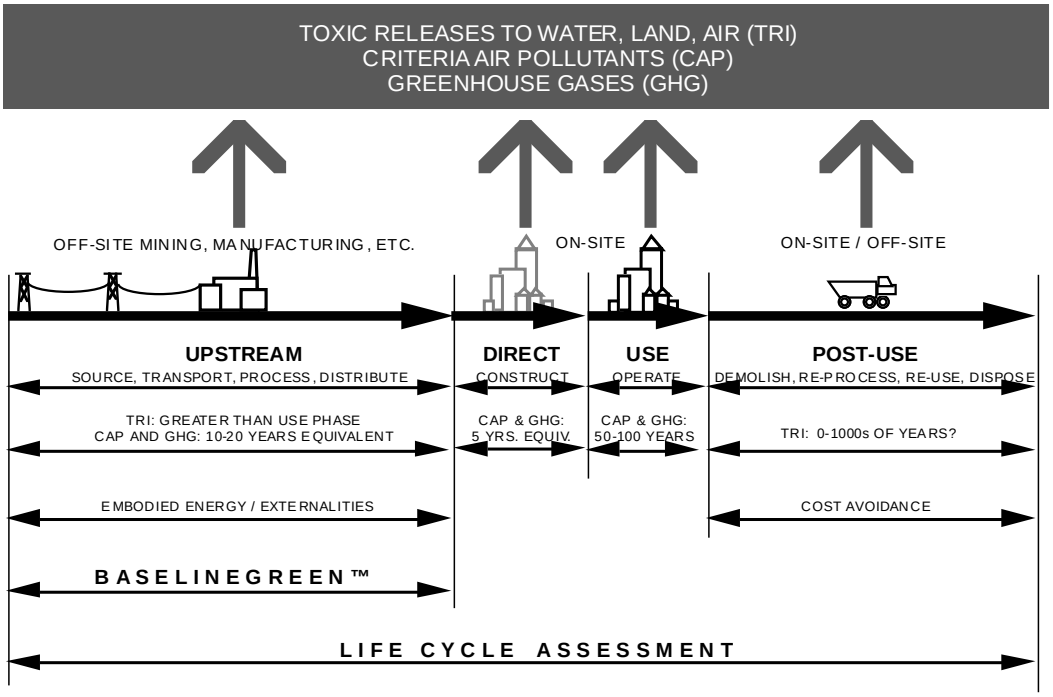


Figure A2.3.1: Relative Impact of Toxic Releases, Criteria Air Pollutants, and Greenhouse Gas Burdens Throughout an Entire Building Life Cycle

Toxic releases to water, land, and air, as well as air pollution and greenhouse gas emissions are associated with each stage of a building's life cycle. Upstream manufacturing of building materials and products typically accounts for a higher amount of toxic releases than other life cycle stages of a building. However, upstream manufacturing of building materials and products typically account for a much lesser amount of air pollution and greenhouse gas emissions than the use life cycle stages (occupancy) of a building. Typically, environmental burdens from energy consumption from fossil fuel generated sources and maintenance and repair activities outweigh upstream burdens. The post-use (downstream) stage of a building's life cycle may pose public health risks and environmental impacts if the materials and products used in the building contain hazardous substances (e.g., asbestos or lead). The BaselineGreen™ analysis examines the environmental burdens associated with the upstream life cycle stage.
[Figure by the authors.]

industry, the total annual value of each type of building for which permits were issued would be an indication of not only the total number of each building type constructed each year, but also the relative extent of environmental impact associated with each building type.

A review of building permits issued by the City of Seattle for five-years (each year from 1996-2000) revealed that the total average annual construction value of single-family residential building was about $100 million and the total average value of office and commercial building was about $300 million. (Most non-residential and non-industrial buildings listed in the permit records were mixed-use, i.e., not solely office nor commercial but some percentage of both.) If associated upstream environmental burdens can be correlated to economic value, then, for any given year, office/commercial buildings will usually have greater total environmental impact than residential (single family) building construction.

Thus, future City of Seattle policies and practices to mitigate impact to salmon habitat may focus to a greater extent on office, retail and multi-family building construction rather than single-family residential construction. However, this may not be true for particular industry types or specific building materials or products. For example, in the case of interior walls and partitions, office and commercial building projects typically specify metal (usually steel) framing components whereas residential projects usually specify wood framing products. Overemphasis on office and commercial construction could therefore underestimate the upstream environmental impact of wood materials and products used in residential construction.

In the results discussed in Sections A4.3 and A4.4 of this report, environmental burdens associated specifically with office and commercial building types are highlighted in the "2nd tier" of the summary tables. This format will aid in the identification of high priority upstream inputs to construction that are unique to office and commercial buildings.

Outside the City of Seattle, the relative proportions of the three different building types might vary. Suburban and rural areas on the city fringe, for example, may contain a higher percentage of residential type construction (by both cost and area) than is found in the city limits. Therefore, the focus of suburban and rural policies and practices may be more on single-family residences. (The amount of construction activity for each of the three building types for areas outside the City of Seattle was not investigated for this report.)

In the results discussed in sections A4.3 and A4.4 of this report, environmental burdens associated specifically with single-family residential buildings are highlighted in the "3rd tier" of the summary tables. This format will aid in the identification of high priority upstream inputs to construction unique to single-family residences.

2.5 Upstream Environmental Impacts: Various Building Scenarios

Since the manufacture of any given building material or product results in some negative environmental impacts, importing all building materials and products from outside the region shifts all associated upstream supply chain environmental burdens to areas outside the Seattle metropolitan region – to the rest of Washington state and the rest of U.S. In a

"business-as-usual" design and construction approach to buildings, this "import-everything" scenario is the process with the least environmental impact on salmon habitat in the Seattle region and is therefore, the most "salmon-friendly." (See the left side – 'Business-as-Usual Approach' – in Figure A2.5.1.)

For "business-as-usual" design and construction of a new office/commercial building in the City of Seattle (Case Study: Seattle Justice Center), upstream external environmental impacts occur primarily outside the metropolitan area (King County) and state of Washington. This condition is due to the type of jobs that are being supported in each of the nested regions. Inside the county and state there are few manufacturing jobs but many less polluting jobs created in the construction sector. Manufacturing, which occurs primarily outside the county and state, is the dominant source of air pollution in the life cycle of inputs to construction due to its high emissions per dollar of output. Additionally, manufacturing is less labor intensive than construction due to the fact that there is more automation usually associated with manufacturing. Thus, this "real-life" example is very close to the "import-everything" scenario described above. Most upstream environmental burdens occur outside the region and will not affect salmon habitats in the Seattle area.

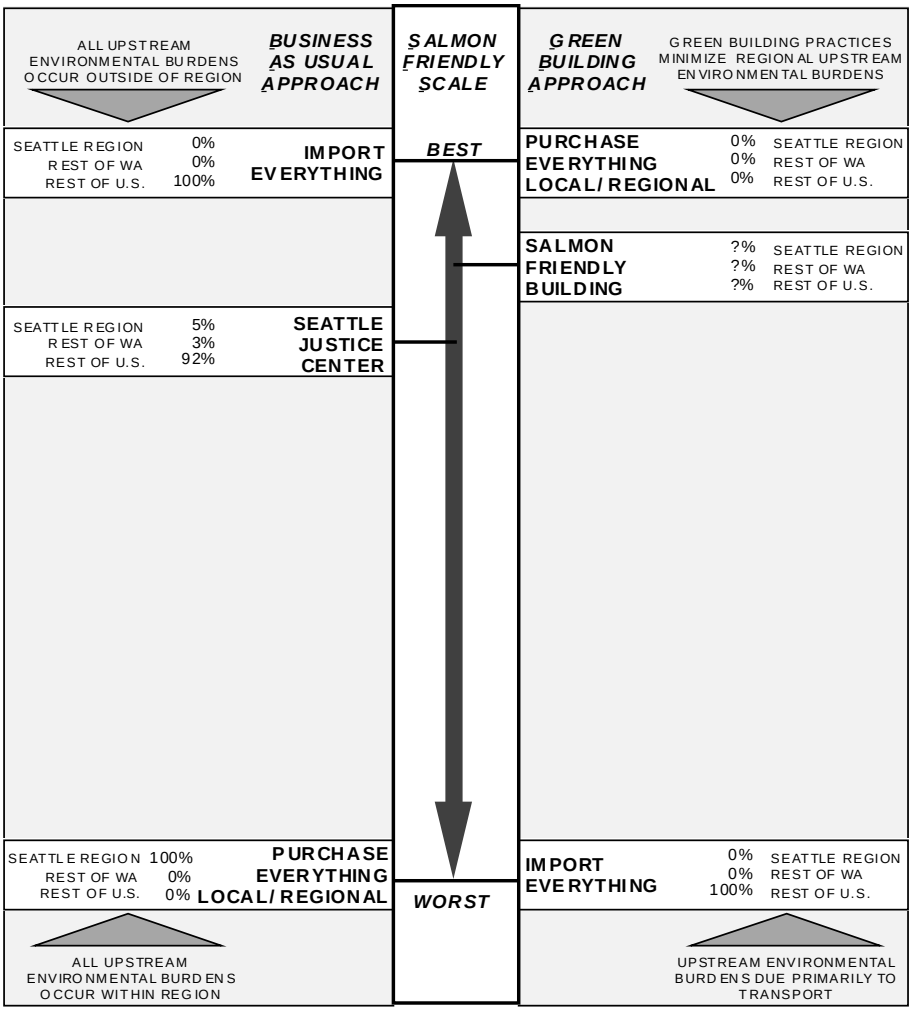


Figure A2.5.1: Various Upstream Environmental Burden Scenarios

In a "Business-as-Usual" approach, importing all building materials and products shifts all the upstream environmental burdens outside the region. Thus, the "import everything" scenario is the most "salmon-friendly." In the case of the SJC project, almost all materials and products were imported and the associated upstream environmental burdens occurred outside the region. The "purchase everything locally and regionally" scenario is the least salmon-friendly" since all associated upstream environmental burdens occur in the region. Under a "Green Building" approach, the ideal condition is the "purchase everything locally and regionally" scenario with zero associated upstream environmental burdens. How close to this ideal is a "salmon-friendly" building?
[Figure by the authors.]

At the bottom of the "Business-as-Usual" spectrum, purchasing all building materials and products from within the region shifts all associated upstream supply chain environmental burdens to areas inside the Seattle metropolitan area. In such a "purchase everything locally and regionally" design and construction approach to buildings, the greatest environmental impact on salmon habitat occurs in the Seattle region and is therefore, the least "salmon-friendly."

Although it may be the most "salmon-friendly" under a "Business-as-Usual" scenario, the "import-everything" scenario is incompatible with a "buy local" approach common to "green building" program recommendations. The "buy local" approach attempts to reduce environmental impacts due to long distance transport of building materials and products while simultaneously stimulating the local economy and employing the local labor force. The ideal scenario is to "purchase everything locally and regionally" with zero upstream environmental impact. (See the right side - 'Green Building Approach' - in Figure A2.5.1.) One question posed by the BaselineGreen™ analysis is how close to this ideal, realistically, can be the definition of a salmon-friendly building?

One step in achieving this ideal is to analyze regional upstream environmental burdens at the level of individual inputs to construction in order to promote business activities in the construction sector that have the least external environmental cost. Conversely, one hopes to avoid selecting building material and/or product types associated with high local and regional environmental burdens.

A3.0 Methodology

Environmental Life Cycle Assessment (LCA) is an approach to the systematic and quantitative study of the upstream and downstream environmental implications of products. Life Cycle Assessments can be conducted using either process-level modeling, or industry/commodity level input/output modeling. This study utilizes the latter approach and limits its scope to only the upstream (or "embodied") environmental consequences of the full set of hundreds of inputs required for a building project. The project input set is fully comprehensive and includes inputs of raw materials, energy, equipment, fabricated products, intermediate products, and services.

By "upstream", we mean all those processes whose outputs are used directly or indirectly to support an activity of interest. Another word for an activity's family of upstream processes is its "supply chain." Theoretically the chain of suppliers is infinite, since all suppliers in turn have their own suppliers. However, we have found from empirical experience that after approximately six to eight supply tiers, the share of total upstream productive output added by additional tiers becomes negligible. This result is in turn caused by the fact that, by definition, the total value of the inputs to a (economically viable) production process must be less than the value of its output.

The BaselineGreen™ analysis makes extensive use of detailed U.S. input/output data from the Bureau of Economic Analysis (BEA) together with federal data on pollution releases by sector from the U.S. Environmental Protection Agency (EPA) and federal data on fuel-specific energy consumption by sector from the U.S. Department of Energy's Energy Information Administration (EIA).

The BEA 1992 detailed Input/Output Accounts provide a starting point for modeling inter-industry flows. The BEA's "Make" and "Use" tables are used directly in our analysis to enable tier-by-tier assessment of results. We retained 498 industries from the BEA tables, including government enterprises such as the US Postal Service, and the 488 BEA commodities produced by these industries. For most manufacturing industries, the BEA industries and commodities match the U.S. four-digit Standard Industrial Classifications (SICs) one-for-one. Outside of manufacturing, some BEA industries represent aggregations of 4-digit SICs, while other BEA industries are composed of portions of one or more 4-digit SICs.

Many establishments in the economy manufacture more than one type of product. This product diversity is even more pronounced among the full set of establishments classified within a single SIC category. The industries and commodities are created by BEA in order to provide a characterization of the inputs and outputs of more homogeneous producing units than those which would arise from developing and publishing the tables on a purely SIC basis - that is, simply using the total production and consumption data for all establishments which are assigned to each SIC as the basis for defining industries as SICs.

Next, fuel-specific energy consumption data (in Btu per dollar of sectoral output) was integrated into the system. The U.S. Census of Mining reports fuel-specific energy

consumption for the mining industries. 1992 Census of Mining data were used in this analysis. Electricity consumption in kWh is also reported for all manufacturing industries (by 4-digit SIC) by the 1992 Census of Manufacturing, as is cost of other purchased fuels. Note that not all purchased fuels are actually combusted; some are used as feedstocks to product production, as in the use of petrochemicals as feedstocks in manufacturing plastics or fertilizers.

The EIA conducts biennial surveys of manufacturing industry energy consumption, by fuel and end-use, and reports both costs and quantities in energy units. The EIA data reports the quantities of each fuel that is combusted. Data for fuel combustion from the 1991 Manufacturing Energy Consumption Survey (MECS), reported EIA 1994, were used in the present analysis.

Fuel-specific manufacturing energy combustion data and the fuel-specific census of mining energy consumption data were converted to provide fuel-specific consumption totals by BEA industry. For nearly all manufacturing industries, the mapping from four-digit SIC to BEA industry is one-to-one; in a few cases, multiple SICs are assigned to a single BEA industry.

For the major energy consuming sectors, MECS reports fuel-specific combustion by four-digit SIC. For sectors that consume smaller amounts of energy, MECS reports fuel-specific combustion by 3-digit or 2-digit SIC. These fewer-digit SICs consist of multiple 4-digit SICs. In these cases, the (1991) MECS-reported fuel shares fuel prices for an aggregated sector were combined with the (1992) Economic Census-reported total cost of fuels for each detailed sector, in order to derive estimated fuel-specific combustion quantities by detailed sector. The total fuel-specific combustion within each 2-digit and 3-digit sector will match those reported by MECS.

EIA also reports fuel-specific sectoral prices for the following non-manufacturing sectors: residential & commercial, industrial, transportation, and electric utilities. These prices (for 1992, concurrent with the BEA consumption data in the Input/Output accounts) were used to convert the non-manufacturing BEA industry fuel and electricity consumption data from dollars to energy units, reported by the EIA in1993.

Finally, fuel-specific sectoral energy combustion data were used to calculate fossil fuel-based carbon emissions by sector, using the fuel-specific carbon emissions coefficients at full combustion provided by the EIA in 1995. These emissions were converted from metric tons of carbon to metric tons of CO2, and were then divided by each sector's 1992 value of product output to obtain CO2 emission intensities, in units of metric tons of CO2 per dollar of 1992 product output.

Data from the EPA's Toxic Release Inventory were obtained for 1999 releases to each media by each 4-digit SIC. These data were mapped to the BEA industries, developing total releases to water and to air per BEA industry per dollar of product output (in producer's prices). These data are used in upstream analyses of the toxic release burdens of building products.

The first step in the BaselineGreen™ analysis process is to define in detail a "baseline building" using typical BEA data for 40 building types that accurately typifies the subject

building in the design stages of a project. Initially, only a building's area, mix of spatial uses, and estimated construction cost need to be determined. This baseline building definition provides the means of generating a bill of materials and their costs which is tailored to the specific building project and which is derived from data for the U.S. construction sector as a whole. This bill of materials typically contains hundreds of items. Subsequently, each "input to construction" item in the bill of materials is analyzed using I/O-LCA methods in order to estimate the total releases of 14 different types of pollution associated with manufacturing and supplying the required quantity of each input item.

In this report, the upstream building-related environmental burden results are presented from three different BaselineGreen™ analyses. The first BaselineGreen™ analysis conducted an Input Environmental Importance Analysis (simultaneous upstream life cycle assessment of all inputs) for three separate types of new construction: new single-family residential construction, new commercial construction, and new office building construction. Each construction type is described in terms of the input requirements of average U.S. construction for that building type in 1992 (the latest year for which this detailed data are available from the Federal Government).

Second, based upon previous work under contract with the City of Seattle, the Seattle Justice Center (SJC) project is presented as an example of new mixed-use office and commercial building construction under a typical "business-as-usual," national input-output model. In this example, almost all building inputs to construction are purchased from manufacturers outside the three-county Seattle metropolitan region. Consequently, the upstream environmental burdens associated with the manufacture of the materials and products specified for the building also originate outside the region. The environmental burdens associated with the small amount of inputs originating within the region are analyzed in detail however, for in the case of any given salmon habitat, even a relatively minute quantity of toxic releases can have a devastating impact.

A third BaselineGreen™ analysis examined the hypothetical case where almost all building inputs to construction for all three building types are purchased from local and regional manufacturers within the three-county Seattle metropolitan region (i.e., a regional input-output model). In this way, the relative magnitude of upstream environmental burdens originating from all local and regional building-related manufacturing was assessed. This model still generates upstream environmental burdens outside the region however, because the supply chain of activities for any given material or product extends beyond regional political boundaries.

These three BaselineGreen™ analyses examined three environmental burden indicators – criteria air pollutants, greenhouse gases, and total toxic releases – for all building-related manufacturing industries categorized by the U.S. Bureau of Economic Analysis (BEA). Criteria air pollutants include nitrogen oxides, sulfur dioxide, particulate matter, volatile organic compounds (VOC's), and carbon monoxide. Greenhouse gases are dominated by CO2. Toxic releases may be one of over 500 chemicals ranging from ammonia to zinc. The BEA categories are similar to the Standard Industrial Classification (SIC) manufacturing industry classification system. The SIC classification system covers the entire field of economic activity in the U.S. It groups industries by Divisions (e.g., mining or manufacturing), Major Groups (e.g., lumber and wood products) and sub-groups (e.g., sawmills and planing mills). For example, BaselineGreen™ results are presented for an

entire group of related manufacturing facilities such as ”sawmills and planning mills” and “glass and glass products” which can be correlated with SIC sub-group categories.

In all three analyses, the total impact of each of the three environmental burdens is estimated on the basis of the cost (as representing quantity) of an input to construction into the building relative to the total cost of that input to construction in the entire U.S. The BaselineGreen™ methodology proportions the upstream environmental burdens of a BEA input item for a particular building based on the annual value of all economic activity associated with that particular BEA input item. For example, if “$ x” million of industrial activity for all steel mills in the U.S. resulted in “z” pounds of air pollution in the entire U.S., and if for a particular building project, 1% of “$ x” was the cost of steel mill products in the building, then the air pollution burden for that building is assumed to be 1% of “z” pounds. Thus, the environmental burden of each BEA input to construction in a building project is scaled to its share of the total national cost of all activity for that input to construction.

It is very important to note that BaselineGreen™ establishes a baseline derived from national average data, and is best conceptualized as a tool for narrowing the search for environmental impacts, or as a tool that flags specific types of industries based on their emissions. Thus after the BaselineGreen™ analysis, further research was conducted to determine how the flagged building related industries in the KPS region or in the state compared to the national industry average relative to emissions. See Section A4.6 for more explanation regarding Baseline Green™ and emissions. Following the three BaselineGreen™ analyses, 1997 and 1999 toxic release inventory data for the State of Washington were reviewed in an attempt to detect and locate specific facilities identified by SIC sub-groups as contributing a significant share of one or more of the three environmental burden indicators. For example, the SJC Project BaselineGreen™ analysis indicated that for material and product inputs originating from the King County region, of all toxic releases within the county, the industry sub-group “wood kitchen cabinets” accounted for about 30% of the total, the highest of all upstream building-related manufacturing industries in the county. A search of toxic release inventory data for King County revealed that a number of manufacturers of wood kitchen cabinets are located in the region. Their toxic release reports were reviewed and their manufacturing facilities were located. Similar findings for other major “high-burden” SIC sub-groups are presented in this report.

Following the toxic release data review, recommendations are made for the selection of environmentally and economically preferred material and product types among many input to construction options.

A4.0 Findings

A4.1 BaselineGreen™ Analysis 1: Model of Environmental Burdens Associated with Average U.S. New Construction of Three Building Types

In the analysis of upstream inputs to average U.S. new construction for three building types, the major building-related upstream manufacturing industries contributing the highest share of environmental burdens are listed in Tables A4.1.1, A4.1.2, and A4.1.3 below. These are cost share burdens, i.e., burdens associated with inputs that account for highest share of total construction cost of all inputs. (Note that total toxic releases have been separated into two categories – toxic releases to water and toxic releases to air.)

Table A4.1.1: Building-Related Industries in the U.S. Contributing the Highest Share (≥ 2%) of Upstream Environmental Burdens for New Residential Construction

Toxic Releases to Water (TRIW)		Toxic Releases to Air (TRIA)		Air Pollution (CAP)		Greenhouse Gases (GHG)	
Hardwood and softwood lumber	7%	Wood kitchen cabinets	8%	Ready-mixed concrete	9%	Ready-mixed concrete	9%
Interior and exterior paints	5%	Mineral wool	8%	Cement, hydraulic	5%	Mineral wool	5%
Hay	5%	Interior and exterior paints	6%	Mineral wool	4%	Cement, hydraulic	4%
Millwork	5%	Bldg. fabricated plastic products	4%	Crushed and broken stone	4%	Millwork	3%
Softwood plywood products	4%	Waferboard and osb	4%	Millwork	3%	Paving mixtures and blocks	3%
Waferboard and osb	3%	Millwork	3%	Solvent and water type paints	3%	Waferboard and osb	3%
Bldg. fabricated plastic products	3%	Bldg. plastic products	3%	Hardwood and softwood lumber	2%	Interior and exterior paints	2%
Wood kitchen cabinets	2%	Plastic plumbing fixtures	2%	Waferboard and osb	2%	Crushed and broken stone	2%
Sawmills and planning mills	2%	Non-current carrying devices	2%	Softwood plywood products	2%	Structural shapes, piling, rein. Bars	2%
Wallcoverings	2%	Unitary air conditioners	2%	Paving mixtures and blocks	2%	Concrete block and brick	2%
Tufted carpets, rugs, artificial grass	2%			Gypsum building materials	2%	Wood kitchen cabinets	2%
Mineral wool	2%			Concrete block and brick	2%	Construction sand and gravel	2%
Rough and dressed lumber, treated	2%			Wood kitchen cabinets	2%	Gypsum building materials	2%
Bldg. plastic products	2%			Bldg. fabricated plastic products	2%	Bldg. fabricated plastic products	2%
Ready-mixed concrete	2%			Structural shapes, piling, rein. bars	2%	Hardwood and softwood lumber	2%
Hardwood plywood	2%						
Plastic plumbing fixtures	2%						

Table A4.1.2: Building-Related Industries in the U.S. Contributing the Highest Share (≥ 2%) of Upstream Environmental Burdens for New Office Construction

Toxic Releases to Water (TRIW)		Toxic Releases to Air (TRIA)		Air Pollution (CAP)		Greenhouse Gases (GHG)	
Solvent and water type paints/coatings	6%	Solvent and water type paints	6%	Cement, hydraulic	6%	Cement, hydraulic	4%
Hard surface floor coverings	6%	Hard surface floor coverings	6%	Ready-mixed concrete	4%	Ready-mixed concrete	4%
Hay	4%	Wood kitchen cabinets	5%	Hard surface floor coverings	4%	Fabricated struct. iron, steel, alum.	4%
Hardwood and softwood lumber	4%	Bldg. fabricated plastic products	4%	Nonferrous wire and cable	4%	Hard surface floor coverings	4%
Millwork	4%	Environmental controls	3%	Fabricated struct. iron, steel, alum.	3%	Solvent and water type paints/coatings	3%
Softwood plywood products	3%	Fabricated struct. iron, steel, alum.	3%	Solvent and water type paints/coatings	3%	Nonferrrous wire and cable	2%
Fabricated struct. iron, steel, alum.	3%	Nonferrous wire and cable	3%	Millwork	2%	Elevators and moving stairs	2%
Bldg. fabricated plastic products	2%	Comm./ind. metal doors and frames	2%	Comm./ind. metal doors and frames	2%	Comm./ind. metal doors and frames	2%
Sawmills and planning mills	2%	Millwork	2%	Other glass products	2%	Millwork	2%
Hardwood flooring	2%	Bldg. Plastics products	2%	Elevators and moving stairs	2%	Other glass products	2%
Wood kitchen cabinets	2%	Elevators and moving stairs	2%	Sheet metal work	2%	Sheet metal work	2%
Rough and dressed lumber, treated	2%	Unitary air conditioners	2%	Custom roll form products	2%	Custom roll form products	2%
Nonferrrous wire and cable	2%	Sheet metal work	2%	Gypsum building materials	2%		
		Partitions and fixtures, exc. Wood	2%				

Table A4.1.3: Building-Related Industries in the U.S. Contributing the Highest Share (≥ 2%) of Upstream Environmental Burdens for New Commercial Construction

Toxic Releases to Water (TRIW)		Toxic Releases to Air (TRIA)		Air Pollution (CAP)		Greenhouse Gases (GHG)	
Prefab metal building systems	7%	Prefab metal building systems	9%	Prefab metal building systems	8%	Prefab metal building systems	9%
Hardwood and softwood lumber	7%	Interior and exterior paints	5%	Cement, hydraulic	5%	Cement, hydraulic	4%
Interior and exterior paints	5%	Wood partitions and fixtures	3%	Fabricated struct. iron, steel, alum.	3%	Fabricated struct. iron, steel, alum.	4%
Millwork	5%	Millwork	3%	Nonferrous wire and cable	3%	Other glass products	3%
Hay	4%	Fabricated struct. iron, steel, alum.	3%	Asphalt felts and coatings	3%	Asphalt felts and coatings	3%
Softwood plywood products	4%	Comm/ind. metal doors and frames	3%	Other glass products	3%	Millwork	2%
Sawmills and planning mills	3%	Bldg. Fabricated plastic products	2%	Millwork	3%	Gypsum building materials	2%
Fabricated struct. iron, steel, alum.	3%	Nonferrous wire and cable	2%	Gypsum building materials	2%	Comm/ind. metal doors and frames	2%
Rough and dressed lumber, treated	2%	Bldg. plastic products	2%	Comm/ind. metal doors and frames	2%	Solvent and water type paints/coatings	2%
Bldg. Fabricated plastic products	2%	Elevators and moving stairs	2%	Solvent and water type paints/coatings	2%	Custom roll form products	2%
		Other glass products	2%	Hardwood and softwood lumber	2%	Elevators and moving stairs	2%
				Elevators and moving stairs	2%	Nonferrous wire and cable	2%
				Ready-mixed concrete	2%	Metal awnings, canopies, cornices	2%
				Softwood plywood products	2%		

Cost share industry groups that consistently appear in each of the three lists of average U.S. new construction for three building types are shown in the first tier summary list in Table A4.1.4 below. Additional industry groups appearing in lists for office and commercial building types are included in the second tier.

Upstream inputs to construction for a building project located in Seattle originate from manufacturers and suppliers from all over the nation (and the world). An analysis of upstream industrial inputs to an average of all U.S. buildings of a particular type therefore, gives us a clue as to which input items might be the highest in terms of associated upstream environmental burdens for the same building type constructed in the Seattle region.

Table A4.1.4: Building-Related Upstream Manufacturing Industries Contributing the Highest Share of Environmental Burdens for Three Types of New Construction in the U.S. – Residential, Office, and Commerecial

Toxic Releases to Water (TRIW)	Toxic Releases to Air (TRIA)	Air Pollution (CAP)	Greenhouse Gases (GHG)
1st Tier: All Three Building Types			
Hay	Millwork	Millwork	Millwork
Hardwood and softwood lumber	Building fabricated plastic products	Cement, hydraulic	Cement, hydraulic
Sawmills and planning mills	Building plastic products	Ready-mixed concrete	Ready-mixed concrete
Softwood plywood products	Solvent and water type paints	Gypsum building materials	Fabricated structural iron, steel, aluminum
Rough and dressed lumber, treated		Solvent and water type paints	Solvent and water type paints
Millwork			
Building fabricated plastic products			
Solvent and water type paints			
2nd Tier: Additional High Share Inputs for Office and Commercial Building Types			
Wood kitchen cabinets	Wood kitchen cabinets	Hardwood and softwood lumber	Commercial/industrial metal doors and frames
Hardwood flooring	Fabricated structural iron, steel, aluminum	Softwood plywood products	Sheet metal work
Fabricated structural iron, steel, aluminum	Sheet metal work	Fabricated structural iron, steel, aluminum	Custom roll form products
Nonferrous wire and cable	Commercial/industrial metal doors and frames	Sheet metal work	Prefab metal building systems
Hard surface floor coverings	Prefab metal building systems	Commercial/industrial metal doors and frames	Nonferrous wire and cable
	Nonferrous wire and cable	Prefab metal building systems	Asphalt felts and coatings
	Hard surface floor coverings	Nonferrous wire and cable	Gypsum building materials
	Other glass products	Hard surface floor coverings	Other glass products
	Elevators and moving stairs	Asphalt felts and coatings	Elevators and moving stairs
	Environmental controls	Other glass products	
	Unitary air conditioners	Elevators and moving stairs	

Table A4.1.4 indicates that for toxic releases to water, high priority items by building cost share for average U.S. construction of the three building types are mainly the following:

For all three building types:
- Hay (apparently due to heavy pesticide use),
- Wood products, rough and finished (such as lumber, plywood, and millwork),
- Solvent and water-based paint products,
- Fabricated plastic products.

For office and retail building types:
- Wood products, finished (flooring and cabinets),
- Fabricated structural metal products,
- Wire,
- Floor coverings.

For toxic releases to air, wood product industries play a lesser role and metal products play a larger role, especially for office and commercial building types. Fabricated metal products are used in office and commercial type buildings more than in residential type buildings.

Again, for criteria air pollutants and greenhouse gases, except for millwork, wood product industries play a lesser role. The high priority items are not metal, but primarily non-metallic mineral-based products. These include products purchased from the following industries:

- Cement,
- Ready-mixed concrete,
- Gypsum building products.

Paint products appear as high priority input item to all three building types. Fabricated metal products, glass products, and mechanical and electrical equipment for buildings are typically a high cost share input item for office and commercial building types.

In summary, the building related industries listed in Table A4.1.4 represent an inventory of "high priority" input items associated with upstream environmental burdens for average construction activity in the U.S. of three building types – residential, office, and commercial. Because a building project located in the Seattle region will typically include inputs to construction from all over the U.S., this list will be compared to the results for an office/commercial building project located in the City of Seattle.

A4.2 BaselineGreen™ Analysis 2: A Typical Mixed-Use Office/ Commercial Building (the Seattle Justice Center Project)

In a typical "business-as-usual" design and construction scenario for office, commercial, or mixed-use buildings, a majority of building materials and products are provided from a national and international list of manufacturers and suppliers. A BaselineGreen™ analysis provides the ability to apportion the upstream external environmental cost impacts of the inputs to construction to three nested geographic regions within which

the Seattle Justice Center (SJC) project is located. In this case those three nested regions are King County, the state of Washington except King County, and the rest of the U.S. except Washington.

In the case of the SJC project, the manufacturing of a large majority of building materials and products and associated environmental burdens occurred outside the Seattle metropolitan area and outside the state of Washington. These data indicate that there exists opposing trends relative to the occurrence of upstream external environmental costs and job related economic impacts. Upstream external environmental impacts occur primarily outside the metropolitan area (King County) and state of Washington. This condition is due to the type of jobs that are being supported in each of the nested regions. Inside the county and state there are few manufacturing jobs but many less polluting jobs created in the construction sector. Manufacturing, which occurs primarily outside the county and state, is the dominant source of air pollution in the life cycle due to its high emissions per dollar of output. Additionally, manufacturing is less labor intensive than construction due to the fact that there is more automation usually associated with manufacturing.

By far the largest share of the total upstream air pollution associated with the SJC project occurs outside of King County and outside of the state of Washington, as shown in the Table A4.2.1 below. The "rest of U.S." share ranges from 75% to 96%, depending upon the air pollutant. The "rest of US" share accounts for 86% of the total economic cost of the criteria air pollutants including carbon dioxide.

Depending upon the air pollutant selected, the share of upstream air pollution occurring in King County ranges from 3% to 16%. King County accounts for 9% of the total economic cost of the criteria air pollutants including carbon dioxide.

The smallest share of the upstream air pollution emissions associated with the SJC project falls in the state of Washington, outside of King County. This share ranges from 1% to 10%, depending upon the air pollutant. Washington accounts for 5% of the total economic cost of the criteria air pollutants including carbon dioxide.

Table A4.2.1: Total Upstream Air Pollution and Toxic Releases for the SJC Project Sorted by Region

Region	VOC (lbs)	NOx (lbs)	CO (lbs)	SO2 (lbs)	PM10 (lbs)	CO2 (lbs)	TRIE (lbs)	Air Pollution Cost ($)
King County	3650	3959	8075	2152	4082	1636211	1337	$ 159,574
Rest of WA	2469	2392	3650	779	2465	350032	857	$ 81,289
Rest of US	32910	24408	143776	64921	19397	14327273	23576	$ 1,449,024
Total	39029	30759	155502	67852	25944	16313516	25770	$ 1,689,887
Pollutant Percentages by Region								
King County	9%	13%	5%	3%	16%	10%	5%	9%
Rest of WA	6%	8%	2%	1%	10%	2%	3%	5%
Rest of US	84%	79%	92%	96%	75%	88%	91%	86%

Upstream (supply chain) toxic releases to water, land, and air have been previously mentioned as the building related environmental factors most directly affecting salmon habitats. As Table A4.2.1 indicates, for the SJC baseline building definition, only 8% of all upstream toxic releases to the environment (TRIE) occur in the state of Washington.

Consequently, an examination of inputs to construction originating in the state of

Table A4.2.2: Manufacturing Industries in King County Contributing the Highest Share (≥ 1%) of Upstream Environmental Burdens for the SJC Project

Total Toxic Releases		Air Pollution		Greenhouse Gases (CO2)	
Wood kitchen cabinets	30%	Sawmills and planing mills	50%	Glass and glass products	10%
Millwork	14%	Glass and glass products	9%	Sawmills and planing mills	8%
Metal partitions and fixtures	9%	Millwork	6%	Metal partitions and fixtures	2%
Glass and glass products	4%	Wood kitchen cabinets	2%	Millwork	1%
Adhesives and sealants	4%	Blast furnaces and steel mills	1%	Blast furnaces and steel mills	1%
Refrigeration and htg. equip.	3%	Adhesives and sealants	1%	Structural wood members	1%
Automatic temp. controls	3%	Wood products, nec	1%	Wood kitchen cabinets	1%
Wood partitions and fixtures	3%	Metal partitions and fixtures	1%	Pipes, valves, pipe fittings	1%
Fabricated metal prod., nec	2%	Veneer and plywood	1%	Adhesives and sealants	1%
Pipes, valves, pipe fittings	2%	Gypsum products	1%		
Misc. fabricated wire prod.	2%	Refrigeration and htg. equip.	1%		
Elevators/moving stairways	2%				
Structural wood members	1%				
Reconstituted wood products	1%				
Blast furnaces and steel mills	1%				
Metal doors, sash, trim	1%				
Wood products, nec	1%				
Steel wire and related prod.	1%				
Fabricated structural metal	1%				

Table A4.2.3: Manufacturing Industries in the Rest of the State of Washington Contributing the Highest Share (≥ 1%) of Upstream Environmental Burdens for the SJC Project

Total Toxic Releases		Air Pollution		Greenhouse Gases (CO2)	
Wood preserving	25%	Veneer and plywood	45%	Veneer and plywood	16%
Hardwood dimension/ flooring	20%	Hardwood dimension/flooring	17%	Wood preserving	12%
Veneer and plywood	12%	Wood preserving	6%	Asphalt felts and coatings	10%
Millwork	8%	Sawmills and planing mills	5%	Hardwood dimension/ flooring	5%
Wood kitchen cabinets	7%	Millwork	4%	Reconstituted wood products	2%
Reconstituted wood products	3%	Asphalt felts and coatings	3%	Glass and glass products	2%
Fabricated metal prod., nec	3%	Wood products, nec	1%	Millwork	2%
Refrigeration and htg. equip.	2%	Glass and glass products	1%	Sawmills and planing mills	2%
Prefab metal buildings	2%	Wood kitchen cabinets	1%	Refrigeration and htg. equip.	1%
Metal partitions and fixtures	1%			Prefab metal buildings	1%
Fabricated structural metal	1%			Fabricated structural metal	1%
Wood products, nec	1%			Fabricated metal prod., nec	1%
				Sheet metal work	1%

Washington will address only a small percentage of the total TRIE releases associated with all inputs to the SJC project. However, due to geographic location, these are the inputs that most directly impact salmon habitat.

Similarly, five air pollutants and one greenhouse gas emission occurring in the state of Washington represents only a small percentage - 14% - of the total releases. Air pollutants and greenhouse gases, however, have a less direct impact on salmon habitat. In fact, due to airshed patterns of atmospheric deposition, air pollution and greenhouse gases originating from outside the region may actually have a more direct impact than air pollution originating from within the region.

Next, upstream external environmental burdens can be examined by industry groups or inputs to construction for those items that account for the bulk of each of the three environmental burdens in each region. Notably, different industry groups dominate the environmental burden in each of the three regions.

In King County, "wood kitchen cabinets," "sawmills and planing mills," and "glass and glass products" top the list of environmental burdens for total toxic releases, air pollutants, and greenhouse gases respectively. For the rest of the state of Washington, "wood preserving" and "veneer and plywood" top the lists, with "hardwood, dimension and flooring" listed as a close second for total toxic releases. A summary of the manufacturing industry groups with the highest contribution to regional upstream air pollution is presented for King County and the rest of the state of Washington in Tables A4.2.2 and A4.2.3.

As mentioned above, BaselineGreen™ links the share of environmental burdens associated with an industry group or input item to the cost of materials and/or products provided by that group or input item in the baseline building type. The environmental burdens are linked to the average dollar value of each item in an average building of this type. Thus, the Tables A4.2.2 and A4.2.3 indicate by building cost share, those items that have the highest burdens. For example, the input item "veneer and plywood" appears at the top of each column is that it represents by cost a larger percentage of inputs than any other item lower in the list.

These rankings will change based on the cost of the emissions. For every dollar of a specific input item into the building, what is the corresponding cost in air pollution? Numerous private and government studies have estimated the "external" costs of air pollution to society in terms of the actual dollars spent on environmental impacts such as health care costs that can be linked to particular pollutants. The approach taken in this report is to employ a set of outlier-corrected higher end dollar values (roughly between centrally tending values and high end extremes) for criteria air pollutants and greenhouse gases combined into a single average value shown in Table A4.2.4 (see sidebar).

The values for external costs of air pollutants and greenhouse gases found in Table A4.2.4 were used to determine the monetary value of a particular upstream environmental burden associated with each input to construction. This monetary value can be expressed as a ratio. The units of the ratio are external cost of upstream environmental burden in dollars per million (or thousand, hundred, etc.) dollars of the market cost of the input to construction. We have called this ratio the "external environmental cost ratio" (EECR) for

Table A4.2.4: Mean of Outlier-Corrected High Values for External Costs of Various Air Pollutants

Air Pollutant	Mean External Cost High Value (Dollars per Ton of Pollutant)
NOx	$16,900
VOCs	$10,100
CO	$2,900
PM10	$26,500
SO2	$10,600

each input to construction. It can be expressed as the following:

$$\text{EECR} = \frac{\text{upstream external environmental cost of input to construction}}{\text{market cost of input to construction}}$$

When this ratio is applied at the level of inputs to construction, we derive the upstream external environmental cost of the more than 200 generic inputs to construction of the building. For any input to construction, if both the EECR and the cost are known, then the total upstream environmental burden for any input to construction in monetary terms can be expressed as:

upstream external environmental cost of input to construction
= EECR x market cost of input to construction

In Table A4.2.5 (see sidebar), the upstream external environmental cost for high priority inputs to construction is listed in the right hand column. The EECR can be used to determine which inputs to construction within product categories have the highest per dollar upstream external environmental cost. For example, in the category Interior Finishes, "tufted carpets" has an EECR of 0.24 meaning that for every $1.00 of market cost, $0.24 is generated in upstream external environmental cost. Compare that with "ceramic wall and floor tile" which has an EECR of 0.17 meaning that $0.17 of upstream external environmental cost is generated for each $1.00 of market cost. Dollar for dollar, tufted carpets have 40% greater upstream external environmental cost than ceramic tile.

In the SJC project as a whole, the market cost of tufted carpet is $1,021,000 generating over $245,000 of upstream external environmental cost. The market cost of ceramic tile is $203,700 generating almost $35,000 of upstream external environmental cost.

Of course, the total upstream external environmental cost for any input to construction has to be adjusted according to the unit cost of that input to construction. In the example above, if the unit cost of ceramic tile is higher than the unit cost of tufted carpet, then the cost difference must be accounted for in determining the upstream external environmental cost in providing a floor finish for a particular area. For example, for a 1,000 square foot room, assume that the materials cost of the tufted carpet is $4.00/sf and the ceramic tile is $6.00/sf. The market cost for the floor finish for that room is $4,000 for tufted carpet and $6,000 for ceramic tile. Multiplying each total market cost by the appropriate EECR yields an upstream external environmental impact of $960 for the tufted carpet and $1,020 for the ceramic tile. Therefore, for this particular application or floor area, the upstream external environmental impacts are nearly equal. (This method of determining the actual upstream external environmental cost for the SJC building is described in greater detail in Section A2.0 of this report.)

What Table A4.2.5 indicates is that per dollar of product, the non-metallic mineral-based products (cement, concrete, gypsum, brick) have the highest upstream environmental impacts for air pollution. They are followed by metal products (especially structural and fabricated steel). Wood products are near the bottom of the list – lumber, structural wood, millwork, and wood cabinets.

As indicated in Tables A4.2.2, A4.2.3, and A4.2.5, per unit ranking of upstream environ-

Table A4.2.5: Summary List of Air Pollution EECR for High Priority Inputs to Construction Located in the State of Washington (Ranked by EECR)

Inputs to Construction by Industry Classification	EECR Cost per $
Cement, hydraulic	2.22
Gypsum building materials	0.63
Structural shapes, sheet piling, and concrete reinforcing bars	0.61
Ready mix concrete	0.49
Brick and structural clay tile	0.41
Concrete block and brick	0.38
Fabricated bar joists and concrete reinforcing bars	0.34
Wallcoverings	0.28
Other glass products including tempered, multiple glazed, & stained	0.26
Interior and exterior architectural solvent and water type paints and coatings	0.25
Commercial and industrial metal doors and frames	0.24
Residential metal doors and frames	0.24
Metal flooring and siding	0.24
Building and construction plastic foam products	0.24
Tufted carpets, rugs, and artificial grass	0.24
Fabricated structural iron, steel, aluminum for buildings	0.23
Fabricated structural metal, nec	0.23
Other fabricated structural metal	0.23
Other granite products including building stone	0.23
Marble building stone, monument tone, and other marble products	0.23
Softwood plywood products, rough, sanded, and specialties	0.23
Hard surface floor coverings	0.23
Hardwood flooring and hardwood dimension lumber and flooring	0.20

mental burdens differs significantly from share of building cost rankings. Some building materials and products are associated with high upstream environmental burdens for a particular building simply because they typically represent a high percentage of the building cost, and therefore, by inference, of the content or volume of all materials and products used in the building. However, there are numerous low cost share materials and products that per unit (by weight, volume, or dollar) have greater upstream environmental burdens than the high cost share input items.

Therefore, to reduce upstream environmental burdens, guidelines should include both high volume/cost share input items and high EECR input items. Industry groups can be sorted either or both ways - by degree of impact due to building cost share/volume and by impact per unit of product cost. Table A4.2.6 (see sidebar this page) lists air pollution burdens for high priority inputs to construction located in the state of Washington ranked by both building cost share and by unit cost of the product (EECR). Note that the lists are quite different. Whereas the highest building cost share input items are primarily wood related products, glass products, and asphalt products, the highest per unit EECR input items are primarily non-metallic mineral (mined) products and steel products.

Two important inputs to construction do not appear on the building cost share list in Table A4.2.6. Even though "ready-mixed concrete" is a high cost share input item in the SJC project (estimated cost $2.3 million), it did not surface in the results of the analysis for the King County and rest of the state of Washington geographic regions. A special discussion of the upstream environmental factors associated with cement and ready mixed concrete is included in Section A4.5.4 of this report. Note here that they should be listed as a high environmental burden input items on two accounts – as a high building cost share input items and as a high EECR items.

Toxic releases to the environment have not been given an external environmental cost. Therefore, an EECR for input item toxic releases does not exist. For the SJC project, results are ranked on a building cost share basis only.

For toxic releases, the highest industry groups in King County and the rest of the state of Washington are listed in Tables A4.2.2 and A4.2.3 above. These two tables indicate many similarities between King County and the rest of the state of Washington for highest priority toxic release input items for the SJC project. The list of high priority items by building cost share includes the following industries:

- Wood products, primarily processed or finished (such as plywood, millwork, and cabinets),
- Steel mills and processed metal (primarily steel) products,
- Glass products,
- Adhesives and sealants,
- Refrigeration and heating equipment,
- Temperature controls,
- Elevators.

At this point in the SJC project analysis, the media of toxic releases – water, land, or air – was unknown. The input items are ranked above according to total toxic releases. Total toxic releases are broken down by media in the following "regional model" Baseline-

(continued)

Table A4.2.5

Inputs to Construction by Industry Classification	EECR Cost per $
Hardwood & softwood lumber, rough & dressed, exc. siding	0.18
Partitions and fixtures, except wood	0.17
Movable partitions except freestanding	0.16
Ceramic wall and floor tile	0.16
Wood poles, piles, & posts	0.15
Rough & dressed lumber, treated	0.13
Millwork	0.12
Wood kitchen cabinets	0.20
Structural wood products	0.18

NOTE: All data includes King County and the rest of the state of Washington. "Rest of U.S." data has been excluded.

Table A4.2.6: Summary List of Air Pollution Associated High Priority Inputs to Construction for the SJC Project Located in the State of Washington Ranked by Cost Share and EECR

Highest Air Pollution Burden Input Items Ranked by Building Cost Share (From Tables A4.2.2 and A4.2.3)

- Sawmills and planning mills
- Veneer and plywood
- Hardwood dimension and flooring
- Millwork
- Glass and glass products
- Wood preserving
- Asphalt felts and coatings
- Wood kitchen cabinets
- Wood products, nec
- Adhesives and sealants
- Metal partitions and fixtures
- Blast furnaces and steel mills
- Gypsum products
- Refrigeration and heating equipment

Highest Air Pollution Burden Input Items Ranked by EECR (≥ $0.25 per dollar of product cost)

- Cement
- Gypsum
- Structural steel
- Ready-mix concrete
- Brick
- Concrete block and brick
- Fabricated bar joists and concrete reinforcing bars
- Wallcoverings
- Other glass products including tempered, multiple glazed, & stained
- Interior and exterior architectural solvent and water type paints and coatings

Green™ analysis.

For greenhouse gas (CO2) emissions associated with the SJC project, the list of highest environmental burden cost share input items is similar to toxic releases. Wood industry and metal industry input items dominate the lists for both King County and the rest of the state of Washington. Again, with the exception of sawmills and planing mills, the wood input items are primarily highly processed or finished products. In addition to wood and metal industries, glass products, adhesives and sealants, refrigeration and heating equipment, and asphalt felts and coatings industry groups appear on the list of greenhouse gases.

As mentioned above, cement and ready-mixed concrete did not appear as high cost share input items to the SJC project. However, both of these inputs, and especially cement production, are associated with high levels of greenhouse gas emissions. A discussion of upstream greenhouse gas emissions associated with the production of cement and ready mixed concrete is included in Section A4.5.4 of this report.

A4.3 BaselineGreen™ Analysis 3: Model of Environmental Burdens Associated with Regionally Based New Construction of Three Building Types

In the third analysis, a hypothetical input/output model assumed that all building materials and products were purchased locally and regionally for each of the three building types – residential, office, and commercial. Since BaselineGreen™ looks at the entire supply chain and is based in national industry averages, there are still impacts outside of the three county region in this hypothetical scenario.

Since the manufacture of any given material or product results in some negative environmental impacts, then all associated supply chain environmental burdens are local/regional in this model of upstream building activity.

A4.3.1 Upstream Environmental Burdens in King, Pierce, and Snohomish Counties

The major building-related upstream manufacturing industries contributing the highest share of toxic release burdens for each of the three building types in King, Pierce, and Snohomish Counties are listed in Tables A4.3.1.1, A4.3.1.2, and A4.3.1.3. These are cost share burdens, i.e., burdens associated with inputs that account for highest share of total construction cost of all inputs. (Note that total toxic releases have now been separated into three categories – toxic releases to water, land, and air.)

Cost share industry groups that consistently appear in the top of each list for King, Pierce, and Snohomish Counties are listed in Table A4.3.1.4. Industries listed in the first tier appear on the toxic release burden lists for all three building types. Industries listed in the second tier appear on the toxic release burden lists for office and commercial building types.

From Table A4.3.1.4 it is important to note that in King, Pierce, and Snohomish Counties, many kinds of wood product industries are associated with a bulk of toxic releases to air. For the first time, “nonwoven fabrics” appears as a high priority environmental burden industry group in the three county region. (Nonwoven fabrics are made of fibers bonded by mechanical, chemical, or thermal means. Geotextile cloth used for erosion control is

an example.) Steel products, caulking compounds, ceramic tile, and brick also appear on the first tier list.

Refuse systems are establishments engaged in the collection and disposal of refuse by processing or incineration, waste treatment plants, landfills, and other disposal sites. Note that on the second tier list, several metal product industries appear, especially steel pro-

Table A4.3.1.1: Hypothetical Local/Regional Scenario: Building-Related Upstream Manufacturing Industries in King, Pierce, and Snohomish Counties Contributing the Highest Share (≥ 2%) of Toxic Release Burdens for New Residential Construction (Note: "Rest of U.S." inputs omitted.)

Toxic Releases to Water		Toxic Releases to Land		Toxic Releases to Air	
Structural shapes, sheet piling & concrete rein. bars	42%	Refuse systems	32%	Mineral wool	25%
Noncurrent-carrying devices	5%	Mineral wool	8%	Waferboard and oriented stand board	19%
Mineral wool	4%	Ready-mixed concrete	6%	Wood kitchen cabinets	11%
Nonwoven fabrics	4%	Waferboard and oriented stand board	5%	Brick & structural clay tile	8%
Waferboard and oriented stand board	4%	Caulking compounds & sealants	4%	Misc. wood products	5%
Ready-mixed concrete	3%	Structural shapes, sheet piling & concrete rein. bars	3%	Millwork	4%
Caulking compounds & sealants	2%	Nonwoven fabrics	2%	Hardboard products	4%
Rough & dressed lumber-treated, not edged	2%	Ceramic wall & floor tile	2%	Softwood plywood products: rough, sanded	2%
Steel nails, spikes, brads, and staples	2%	Rough & dressed lumber-treated, not edged	2%	Hardwood and softwood lumber, rough & dressed	2%
Hardwood and softwood lumber, rough & dressed	2%	Wood kitchen cabinets	2%		
		Builders' hardware	2%		

Table A4.3.1.2: Hypothetical Local/Regional Scenario: Building-Related Upstream Manufacturing Industries in King, Pierce, and Snohomish Counties Contributing the Highest Share (≥ 2%) of Toxic Release Burdens for New Office Construction (Note: "Rest of U.S." inputs omitted.)

Toxic Releases to Water		Toxic Releases to Land		Toxic Releases to Air	
Structural shapes, sheet piling & concrete rein. bars	12%	Refuse systems	37%	Wood kitchen cabinets	16%
Nonwoven fabrics	6%	Ready-mixed concrete	4%	Brick & structural clay tile	12%
Steel power boilers, except parts and attachments	5%	Caulking compounds & sealants	4%	Millwork	6%
Noncurrent-carrying devices	4%	Nonwoven fabrics	2%	Hardboard products	6%
Fabricated structural iron, steel and aluminum	3%	Ceramic wall & floor tile	2%	Fabricated structural iron, steel and aluminum	4%
Caulking compounds & sealants	3%	Unitary air conditioners	2%	Commercial and Industrial metal doors and frames	3%
Ready-mixed concrete	3%	Rough & dressed lumber-treated, not edged	2%	Hard surface floor coverings	3%
Metal tanks and vessels	3%	Builders' hardware	2%	Elevators and moving stairways	3%
Steel nails, spikes, brads, and staples	2%			Softwood plywood products: rough, sanded	2%
Rough & dressed lumber-treated, not edged	2%			Misc. wood products	2%
Fabricated plate work (boiler shops), nsk	2%			Hardwood and softwood lumber, rough & dressed	2%
Unitary air conditioners	2%			Hardwood flooring	2%
Custom roll form products	2%			Partitions and fixtures, except wood, nsk	2%
Ferrous pressure vessels and tanks	2%				
Hardwood and softwood lumber, rough & dressed	2%				
Ceramic wall & floor tile	2%				

Table A4.3.1.3: Hypothetical Local/Regional Scenario: Building-Related Upstream Manufacturing Industries in King, Pierce, and Snohomish Counties Contributing the Highest Share (≥ 2%) of Toxic Release Burdens for New Commercial Construction (Note: "Rest of U.S." inputs omitted.)

Toxic Releases to Water		Toxic Releases to Land		Toxic Releases to Air	
Steel power boilers, except parts and attachments	12%	Refuse systems	36%	Prefabricated metal building systems	15%
Prefabricated metal building systems	7%	Caulking compounds & sealants	4%	Brick & structural clay tile	9%
Nonwoven fabrics	6%	Nonwoven fabrics	2%	Millwork	7%
Structural shapes, sheet piling & concrete rein. bars	5%	Prefabricated metal building systems	2%	Hardboard products	7%
Noncurrent-carrying devices	5%	Asphalt felts & coatings nsk	2%	Wood partitions and fixtures, nsk	4%
Fabricated structural iron, steel and aluminum	3%	Ceramic wall & floor tile	2%	Fabricated structural iron, steel and aluminum	4%
Caulking compounds & sealants	3%	Rough & dressed lumber-treated, not edged	2%	Commercial and Industrial metal doors and frames	4%
Rough & dressed lumber-treated, not edged	3%	Unitary air conditioners	2%	Hardwood and softwood lumber, rough & dressed	3%
Hardwood and softwood lumber, rough & dressed	3%	Wood partitions and fixtures, nsk	2%	Softwood plywood products: rough, sanded	3%
Metal tanks and vessels	2%			Elevators and moving stairways	3%
Steel nails, spikes, brads, and staples	2%			Misc. wood products	2%
Fabricated plate work (boiler shops), nsk	2%			Rough & dressed lumber-treated, not edged	2%
All other current carrying wiring devices	2%			Sawmills and planing mills, nsk	2%
Custom roll form products	2%				
Ceramic wall & floor tile	2%				
Unitary air conditioners	2%				

Table A4.3.1.4: Hypothetical Local/Regional Scenario: Building-Related Upstream Manufacturing Industries in King, Pierce, and Snohomish Counties Contributing the Highest Share of Toxic Release Burdens Coimmon to Three Types of New Construction – Residential, Office, and Commercial (Note: "Rest of U.S." inputs omitted.)

Toxic Releases to Water	Toxic Releases to Land	Toxic Releases to Air
1st Tier: All Three Building Types		
Nonwoven fabrics	Nonwoven fabrics	Hardwood and softwood lumber, rough & dressed
Rough & dressed lumber-treated, not edged	Rough & dressed lumber-treated, not edged	Softwood plywood products: rough, sanded
Hardwood and softwood lumber, rough & dressed	Caulking compounds & sealants	Hardboard products
Caulking compounds & sealants	Ceramic wall & floor tile	Miscellaneous wood products
Structural shapes, sheet piling & concrete reinforcing bars	Refuse systems	Wood partitions and fixtures, nsk
Steel nails, spikes, brads, and staples		Millwork
Noncurrent-carrying devices		Brick & structural clay tile
2nd Tier: Additional High Share Inputs for Office and Commercial Buildings		
Steel power boilers, except parts and attachments	Wood partitions and fixtures, nsk	Wood kitchen cabinets
Fabricated structural iron, steel and aluminum	Ready-mixed concrete	Elevators and moving stairways
Metal tanks and vessels	Builders' hardware	Fabricated structural iron, steel and aluminum
Fabricated plate work (boiler shops), nsk	Unitary air conditioners	
Custom roll form products		
Ready-mixed concrete		
Ceramic wall & floor tile		
3d Tier: Additional High Share Inputs for Residential Buildings		
Mineral wool	Mineral wool	Mineral wool
Waferboard and oriented strandboard	Waferboard and oriented strandboard	Waferboard and oriented strandboard
	Wood kitchen cabinets	Wood kitchen cabinets
	Structural shapes, sheet piling & concrete reinforcing bars	

ducts. Ready-mixed concrete, ceramic tile, builder's hardware, unitary air conditioners, elevators, and wood kitchen cabinets also appear. In the third tier list, mineral wool and waferboard/osb products appear.

A4.3.2 Upstream Environmental Burdens in the Rest of the State of Washington

Even though building materials and products are purchased locally or regionally, supply chain activities in the manufacturing sector of the economy extend beyond the political boundaries of the three county region. These supply chain industrial activities extend into the state of Washington and the rest of the U.S.

The major building-related upstream manufacturing industries contributing the highest share of toxic release burdens for each of the three building types in the rest of the state of Washington are listed in Tables A4.3.2.1, A4.3.2.2, and A4.3.2.3 below. These are cost share

Table A4.3.2.1: Hypothetical Local/Regional Scenario: Building-Related Upstream Manufacturing Industries in the Rest of the State of Washington Contributing the Highest Share (≥ 2%) of Toxic Release Burdens for New Residential Construction (Note: "Rest of U.S." inputs omitted.)

Toxic Releases to Water		Toxic Releases to Land		Toxic Releases to Air	
Vitreous plumbing fixtures	37%	Mineral wool	14%	Mineral wool	17%
Nonferrous wire and cable, including optical cable	23%	Ready-mixed concrete	13%	Ready-mixed concrete	15%
Plumbing fittings and brass goods	7%	Caulking compounds & sealants	9%	Caulking compounds & sealants	8%
Other vitreous plumbing fixtures	7%	Structural shapes, sheet piling & concrete rein. bars	5%	Vitreous plumbing fixtures	6%
Waferboard and oriented strandboard	5%	Vitreous plumbing fixtures	5%	Nonferrous wire and cable, including optical cable	6%
Nonwoven fabrics	5%	Waferboard and oriented strandboard	5%	Rough & dressed lumber-treated	3%
Other electronic equipment, nec (including automatic garage door openers)	2%	Rough & dressed lumber-treated	4%	Ceramic wall & floor tile	3%
Vacuum cleaner complete power units, central system type	2%	Ceramic wall & floor tile	3%	Plumbing fittings and brass goods	2%
Other insulated or covered wire and cable nec	2%	Nonferrous wire and cable, including optical cable	2%	Residential metal doors and frames	2%
Misc. wood products	2%	Paving mixtures & blocks	2%	Structural shapes, sheet piling & concrete rein. bars	2%
Hardboard products	2%	Wood preserving, nsk	2%	Softwood plywood products: rough, sanded	2%
		Noncurrent-carrying devices	2%		

Table A4.3.2.2: Hypothetical Local/Regional Scenario: Building-Related Upstream Manufacturing Industries in the Rest of Washington State Contributing the Highest Share (≥ 2%) of Toxic Release Burdens for New Office Construction (Note: "Rest of U.S." inputs omitted.)

Toxic Releases to Water		Toxic Releases to Land		Toxic Releases to Air	
Nonferrous wire and cable, including optical cable	70%	Nonferrous wire and cable, including optical cable	12%	Nonferrous wire and cable, including optical cable	22%
Plumbing fittings and brass goods	7%	Caulking compounds & sealants	11%	Ready-mixed concrete	9%
Alarm systems, including electric sirens and horns	6%	Ready-mixed concrete	10%	Caulking compounds & sealants	8%
Other insulated or covered wire and cable nec	4%	Rough & dressed lumber-treated, not edged	4%	Commercial and Industrial metal doors and frames	5%
Nonwoven fabrics	4%	Ceramic wall & floor tile	4%	Plumbing fittings and brass goods	3%
Intercommunication systems, incl inductive paging systems	2%	Wood poles, piles, and posts	2%	Rough & dressed lumber-treated, not edged	3%
Hardboard products	2%	Unitary air conditioners	2%	Ceramic wall & floor tile	3%
				Water proofing compounds	2%
				Boiler compounds	2%
				Residential metal doors and frames	2%
				Softwood plywood products: rough, sanded	2%

burdens, i.e., burdens associated with inputs that account for highest share of total construction cost of all inputs. (Note that total toxic releases have now been separated into three categories – toxic releases to water, land, and air.)

Cost share industry groups consistently in the top of each list for the rest of the state of Washington are listed in Table A4.3.2.4 below. Industries listed in the first tier are ones

Table A4.3.2.3: Hypothetical Local/Regional Scenario: Building-Related Upstream Manufacturing Industries in the Rest of Washington State Contributing the Highest Share (≥ 2%) of Toxic Release Burdens for New Commercial Construction (Note: "Rest of U.S." inputs omitted.)

Toxic Releases to Water		Toxic Releases to Land		Toxic Releases to Air	
Nonferrous wire and cable, including optical cable	67%	Caulking compounds & sealants	11%	Nonferrous wire and cable, including optical cable	20%
Plumbing fittings and brass goods	7%	Nonferrous wire and cable, including optical cable	10%	Caulking compounds & sealants	8%
Electrical door openers, except garage door openers	4%	Rough & dressed lumber-treated	6%	Commercial and Industrial metal doors and frames	6%
Alarm systems, including electric sirens and horns	4%	Ceramic wall & floor tile	4%	Prefabricated metal building systems	4%
Other insulated or covered wire and cable nec	4%	Ready-mixed concrete	4%	Rough & dressed lumber-treated, not edged	4%
Nonwoven fabrics	4%	Asphalt felts & coatings nsk	3%	Ready-mixed concrete	4%
Hardboard products	2%	Wood partitions and fixtures, nsk	2%	Plumbing fittings and brass goods	3%
		Prefabricated metal building systems	2%	Ceramic wall & floor tile	3%
		Commercial and Industrial metal doors and frames	2%	Softwood plywood products: rough, sanded	2%
				Asphalt felts & coatings nsk	2%
				Residential metal doors and frames	2%
				Water proofing compounds	2%
				Boiler compounds	2%
				Concrete curing & floor hardening materials	2%

Table A4.3.2.4: Hypothetical Local/Regional Scenario: Building-Related Upstream Manufacturing Industries in the Rest of Washington State Contributing the Highest Share of Toxic Release Burdens Coimmon to Three Types of New Construction – Residential, Office, and Commercial (Note: "Rest of U.S." inputs omitted.)

Toxic Releases to Water	Toxic Releases to Land	Toxic Releases to Air
1st Tier: All Three Building Types		
Hardboard products	Rough & dressed lumber-treated, not edged	Rough & dressed lumber-treated, not edged
Plumbing fittings and brass goods	Caulking compounds & sealants	Softwood plywood products: rough, sanded
Nonferrous wire and cable, including optical cable	Ready-mixed concrete	Caulking compounds & sealants
Other insulated or covered wire and cable nec	Ceramic wall & floor tile	Ready-mixed concrete
Nonwoven fabrics	Nonferrous wire and cable, including optical cable	Ceramic wall & floor tile
		Nonferrous wire and cable, including optical cable
		Residential metal doors and frames
		Plumbing fittings and brass goods
2nd Tier: Additional High Share Items for Office and Commercial Buildings		
Alarm systems, including electric sirens and horns		Water proofing compounds
		Boiler compounds
		Concrete curing & floor hardening materials
3d Tier: Additional High Share Items for Residential Buildings		
Vitreous plumbing fixtures	Mineral wool	Mineral wool
Waferboard and oriented strandboard	Vitreous plumbing fixtures	Vitreous plumbing fixtures
Miscellaneous wood products	Structural shapes, sheet piling & concrete rein. bars	Structural shapes, sheet piling & concrete rein. bars
	Waferboard and oriented strandboard	
	Wood preserving, nsk	
	Paving mixtures & blocks	

that appear on the toxic release burden lists for all three building types. Industries listed in the second tier are ones that appear on the toxic release burden lists for two of the three building types.

In Table A4.3.2.4 note that in the rest of the state of Washington, wood product industries play a lesser role for all types of toxic releases. The input items nonwoven fabrics, nonferrous wire and cable, other wire and cable, plumbing fittings, and residential metal doors and frames all appear in the first tier list. Caulking compounds, ceramic tile, and ready-mixed concrete also appear on the list for all three building types.

A4.4 Summary of Three BaselineGreen™ Analyses

Tables A.4.4.1 through A4.4.5 below are comprehensive summaries of all the industry groups flagged by the three BaselineGreen™ analyses located anywhere in the state of Washington associated with the five environmental burden indicators discussed above: toxic releases to water, toxic releases to land, toxic releases to air, criteria air pollutants, and greenhouse gases. By comprehensive we mean that no industry has been omitted from a list simply because its share of a particular environmental burden may be less than that of other industries. Even a small toxic spill into a sensitive salmon habitat can have a major impact. Once again, it is important to note that the data in the following tables is based on a baseline derived from national averages.

Each table sorts the input industries by SIC code and has a three-tier format. The first tier lists flagged industries with inputs to all three building types. The second tier lists flagged industries that typically have inputs to office and commercial buildings. The third tier lists flagged industries common to residential buildings.

Tables A4.4.1 through A4.4.5 will be used to guide the investigation into toxic release inventory, air pollution, and greenhouse gas data in the remainder of this report. For example, Table A4.4.1 indicates that the industry group “nonwoven fabrics” is associated with toxic releases to water for all building types. The SIC code for this industry is 2297 under the major SIC code of 22. State of Washington and U.S. EPA records for toxic release inventory reports will be examined to determine if such an industrial facility or facilities exist in the three county region and the rest of the state of Washington. If such a facility can be identified and located, then its toxic release report will be reviewed and compared to a benchmark – the average toxic releases to water for all similar industrial facilities in the U.S.

If green building practices include specifying local and regional materials, then this process attempts to make certain that local and regional manufacturers and suppliers of building materials and products are not associated with negative upstream environmental factors affecting salmon habitat. It is a first step in identifying local and regional “salmon-friendly” building materials and products.

This section of the report presents the findings of the three BaselineGreen™ analyses simply as the comprehensive summary lists presented in the five tables below. A detailed discussion of toxic release, air pollution, and greenhouse gas data for local, regional, and statewide building related industries and identification and location of these industries is included in sections 4.5 and 4.6 below.

Table A4.4.1: Comprehensive List of Industries in the State of Washington Associated with Upstream Toxic Releases to Water Identified by BaselineGreen™ Sorted by SIC Code (Based on National Industry Averages)

SIC Code Major Group	SIC Code Industry Number	Industry Group
1st Tier: Inputs to All Three Building Types		
01 Agriculture	0139	Hay
22 Textiles	2297	Nonwoven fabrics
24 Lumber and Wood Products	2421 and 2426	Hardwood and softwood lumber, rough & dressed Hardwood and softwood lumber
	2431	Millwork
	2436	Softwood plywood products
	2491	Rough & dressed lumber-treated, not edged
	2493	Hardboard products
28 Chemicals	2851	Solvent and water type paints
	2891	Caulking compounds & sealants
33 Primary Metal	3312	Structural shapes, sheet piling & concrete reinforcing bars
	3315	Steel nails, spikes, brads, and staples
	3356 and 3357	Nonferrous wire and cable, including optical cable Other insulated or covered wire and cable nec
34 Fabricated Metal	3432	Plumbing fittings and brass goods
	3449	Structural shapes, sheet piling & concrete reinforcing bars
36 Electrical Equipment	3644	Noncurrent-carrying devices
2nd Tier: Additional Inputs for Office and Commercial Buildings		
32 Stone, Clay, Glass, and Concrete	3253	Ceramic wall & floor tile
	3273	Ready-mixed concrete
34 Fabricated Metal	3441	Fabricated structural iron, steel and aluminum
	3443	Fabricated plate work (boiler shops), nsk
	3443	Steel power boilers, except parts and attachments
	3443	Metal tanks and vessels
	3449	Custom roll form products
36 Electrical Equipment	3679	Alarm systems, including electric sirens and horns
3d Tier: Additional Inputs for Residential Buildings		
24 Lumber and Wood Products	2493	Waferboard and oriented strandboard
	2499	Miscellaneous wood products
32 Stone, Clay, Glass, and Concrete	3261	Vitreous china plumbing fixtures
	3296	Mineral wool

Table A4.4.2: Comprehensive List of Industries in the State of Washington Associated with Upstream Toxic Releases to Land Identified by BaselineGreen™ Sorted by SIC Code (Based on National Industry Averages)

SIC Code Major Group	SIC Code Industry Number	Industry Group
1st Tier: Inputs to All Three Building Types		
22 Textiles	2297	Nonwoven fabrics
24 Lumber and Wood Products	2491	Rough & dressed lumber-treated, not edged
28 Chemicals	2891	Caulking compounds & sealants
32 Stone, Clay, Glass, and Concrete	3253	Ceramic wall & floor tile
	3273	Ready-mixed concrete
49 Electric, Gas, and Sanitary Services	4923	Refuse systems
2nd Tier: Additional Inputs to Office and Commercial Buildings		
34 Fabricated Metal	3429	Builders' hardware
35 Industrial & Commercial Machinery	3585	Unitary air conditioners
3d Tier: Additional Inputs to Residential Buildings		
24 Lumber and Wood Products	2431	Wood kitchen cabinets
	2491	Wood preserving
	2493	Waferboard and oriented strandboard
32 Stone, Clay, Glass, and Concrete	3261	Vitreous china plumbing fixtures
	3296	Mineral wool
33 Primary Metal	3312	Structural shapes, sheet piling & concrete reinforcing bars

Table A4.4.3: Comprehensive List of Industries in the State of Washington Associated with Upstream Toxic Releases to Air Identified by BaselineGreen™ Sorted by SIC Code (Based on National Industry Averages)

SIC Code Major Group	SIC Code Industry Number	Industry Group
1st Tier: Inputs to All Three Building Types		
24 Lumber and Wood Products	2421 and 2426	Hardwood and softwood lumber, rough & dressed Hardwood and softwood lumber Hardwood dimension and flooring
	2431	Millwork
	2431	Wood kitchen cabinets
	2431	Wood partitions and fixtures, nsk
	2436	Softwood plywood products
	2436	Veneer and plywood
	2491	Rough & dressed lumber-treated, not edged
	2491	Wood preserving
	2493	Hardboard products
	2499	Miscellaneous wood products
28 Chemicals	2851	Solvent and water type paints
	2891	Caulking compounds & sealants
32 Stone, Clay, Glass, and Concrete	3253	Ceramic wall & floor tile
	3273	Ready-mixed concrete
	3297	Brick & structural clay tile
33 Primary Metal	3312	Structural shapes, sheet piling & concrete reinforcing bars
	3315	Steel nails, spikes, brads, and staples
	3356 and 3357	Nonferrous wire and cable, including optical cable
		Other insulated or covered wire and cable nec
34 Fabricated Metal	3432	Plumbing fittings and brass goods
	3449	Structural shapes, sheet piling & concrete reinforcing bars
36 Electrical Equipment	3644	Noncurrent-carrying devices
2nd Tier: Additional Inputs to Office and Commercial Buildings		
25 Furniture and Fixtures	2541	Wood partitions and fixtures
	2542	Metal partitions and fixtures
28 Chemicals and Allied Products	2899	Waterproofing compounds
	2899	Boiler compounds
	2899	Concrete curing and floor hardening compounds
30 Rubber and Misc. Plastics Products	3089	Hard surface floor coverings
32 Stone, Clay, Glass, and Concrete	3211 and 3231	Glass and glass products
34 Fabricated Metal	3441	Fabricated structural iron, steel and aluminum
	3442	Commercial and industrial metal doors and frames
	3443	Fabricated plate work (boiler shops), nsk
	3443	Steel power boilers, except parts and attachments
	3443	Metal tanks and vessels
	3449	Custom roll form products
35 Industrial and Commercial Equip.	3534	Elevators and moving stairways
36 Electrical Equipment	3679	Alarm systems, including electric sirens and horns

(continued)

Table A4.4.3

SIC Code Major Group	SIC Code Industry Number	Industry Group
3d Tier: Additional Inputs to Residential Buildings		
24 Lumber and Wood Products	2493	Waferboard and oriented strandboard
	2499	Miscellaneous wood products
30 Rubber and Misc. Plastics Products	3088	Plastic plumbing fixtures
	3089	Building plastics products
32 Stone, Clay, Glass, and Concrete	3261	Vitreous china plumbing fixtures
	3296	Mineral wool
34 Fabricated Metal	3442	Residential metal doors and frames

Table A4.4.4: Comprehensive List of Industries in the State of Washington Associated with Upstream Criteria Air Pollutant Releases Identified by BaselineGreen™ Sorted by SIC Code (Based on National Industry Averages)

SIC Code Major Group	SIC Code Industry Number	Industry Group
1st Tier: Inputs to All Three Building Types		
24 Lumber and Wood Products	2421 and 2426	Hardwood and softwood lumber, rough & dressed Hardwood and softwood lumber Hardwood dimension and flooring
	2431	Millwork
	2431	Wood kitchen cabinets
	2436	Softwood plywood products
	2436	Veneer and plywood
	2491	Wood preserving
	2499	Miscellaneous wood products
28 Chemicals	2851	Solvent and water type paints
32 Stone, Clay, Glass, and Concrete	3241	Cement
	3273	Ready-mixed concrete
	3275	Gypsum building products
33 Primary Metal	3312	Structural shapes, sheet piling & concrete reinforcing bars
	3356 and 3357	Nonferrous wire and cable, including optical cable Other insulated or covered wire and cable nec
34 Fabricated Metal	3441 and 3449	Structural shapes, sheet piling & concrete reinforcing bars
2nd Tier: Additional Inputs to Office and Commercial Buildings		
24 Lumber and Wood Products	2421	Sawmills and planning mills
	2491	Wood preserving
25 Furniture and Fixtures	2542	Metal partitions and fixtures
28 Chemicals and Allied Products	2891	Adhesives and sealants
29 Petroleum Refining & Related Industries	2951	Asphalt felts and coatings
30 Rubber and Misc. Plastics Products	3069	Wallcoverings
	3089	Hard surface floor coverings
32 Stone, Clay, Glass, and Concrete	3211 and 3231	Glass and glass products
	3251	Brick and structural clay tile
33 Primary Metal	3312	Blast furnaces and steel mills
34 Fabricated Metal	3441	Fabricated structural iron, steel and aluminum
	3442	Commercial and industrial metal doors and frames
	3443	Steel power boilers, except parts and attachments
	3444	Sheet metal work
	3449	Custom roll form products
35 Industrial and Commercial Equip.	3534	Elevators and moving stairways
	3585	Refrigeration and heating equipment
3rd Tier: Additional Inputs to Residential Buildings		
14 Mining and Quarrying Nonmetallic Minerals	1429	Crushed and broken stone
24 Lumber and Wood Products	2493	Waferboard and oriented strandboard
30 Rubber and Misc. Plastics Products	3089	Building plastics products
32 Stone, Clay, Glass, and Concrete	3251, 3271	Paving mixtures and blocks
	3271	Concrete block and brick
	3296	Mineral wool

Table A4.4.5: Comprehensive List of Industries in the State of Washington Associated with Upstream Greenhouse Gas Emissions Identified by BaselineGreen™ Sorted by SIC Code (Based on National Industry Averages)

SIC Code Major Group	SIC Code Industry Number	Industry Group
1st Tier: Inputs to All Three Building Types		
24 Lumber and Wood Products	2431	Millwork
28 Chemicals	2851	Solvent and water type paints
32 Stone, Clay, Glass, and Concrete	3241	Cement
	3273	Ready-mixed concrete
34 Fabricated Metal	3441	Fabricated structural iron, steel and aluminum
2nd Tier: Additional Inputs to Office and Commercial Buildings		
24 Lumber and Wood Products	2421	Sawmills and planning mills
	2421 and 2426	Hardwood dimension and flooring
	2431	Wood kitchen cabinets
	2439	Structural wood members
	2436	Veneer and plywood
	2491	Wood preserving
	2493	Reconstituted wood products
25 Furniture and Fixtures	2542	Metal partitions and fixtures
28 Chemicals and Allied Products	2891	Adhesives and sealants
29 Petroleum Refining & Related Industries	2951	Asphalt felts and coatings
32 Stone, Clay, Glass, and Concrete	3211 and 3231	Glass and glass products
	3275	Gypsum building products
33 Primary Metal	3312	Blast furnaces and steel mills
34 Fabricated Metal	3441	Fabricated structural metal
	3442	Commercial and industrial metal doors and frames
	3443	Steel power boilers, except parts and attachments
	3444	Sheet metal work
	3448	Prefabricated metal buildings
	3449	Custom roll form products
	3498	Pipes' valves, pipe fittings
	3499	Fabricated metal products, nec
35 Industrial and Commercial Equip.	3534	Elevators and moving stairways
	3585	Refrigeration and heating equipment
3rd Tier: Additional Inputs to Residential Buildings		
14 Mining and Quarrying Nonmetallic Minerals	1429	Crushed and broken stone
	1442	Construction sand and gravel
24 Lumber and Wood Products	2421	Hardwood and softwood lumber
	2431	Wood kitchen cabinets
	2493	Waferboard and oriented strandboard
30 Rubber and Misc. Plastics Products	3089	Building plastics products
32 Stone, Clay, Glass, and Concrete	3251, 3271	Paving mixtures and blocks
	3271	Concrete block and brick
	3296	Mineral wool
34 Fabricated Metal Products	3441 and 3449	Structural shapes, sheet piling & concrete reinforcing bars

A4.5 Toxic Release Inventory, Air Pollution, and Greenhouse Gas Emissions Gas Emissions Data for Industrial Facilities

Following BaselineGreen™, a review of toxic release inventory, criteria air pollutants, and greenhouse gas emissions reports for the state of Washington was undertaken to identify point source industries for these upstream environmental burdens. The industry groups and/or facilities investigated were the high priority industry groups identified in Tables A4.4.1 through A4.4.5 in Section A4.4 above.

This review of toxic release inventory (TRI) data attempts to include all industrial facilities in the State of Washington. However, the TRI data used for BaselineGreen™ relies on reports submitted by the industries themselves. It is possible that some releases may be un- or under-reported and that some TRI reports contain errors or may have missing information.

A4.5.1 Toxic Releases to Water

Table A4.5.1.1 below lists the industry groups that were identified in the BaselineGreen™ analysis as sources of toxic releases to water in the King, Pierce, and Snohomish (KPS) three county region and in the rest of the state of Washington. The industry groups listed in this table were the ones that were selected for further investigation because they are the "first tier" items, i.e., upstream industrial inputs to all three building types. This detailed investigation included a review of TRI reports and, in some cases, calls to facility personnel to verify information.

The investigation of 1999 TRI reports for all industrial facilities in the state of Washington revealed 70 pounds of direct upstream burdens associated with toxic releases to water for the building related industry groups or facilities listed above. All of this burden came from three facilities manufacturing treated lumber (SIC 2491) as shown in Table A4.5.1.2 below. Creosotes used for treating lumber are derived from coal tar; they are known skin irritants and are indicated to be probably carcinogenic to humans by the International Agency for Research on Cancer. Arsenic is a known human carcinogen, and copper is not known to cause cancer. Rather than conduct a detailed investigation of the effects of these releases on salmon, the authors recommend application of the precautionary principle; if these chemicals are harmful to humans, they are most likely harmful to salmon as well.

To put building related industries in perspective with all other industries, it is worthwhile to examine the toxic releases to water of the paper industry. A single paper pulp plant located in western Washington releases more than 500,000 pounds of toxic releases to

Table A4.5.1.1: Industry Groups in KPS Counties and the State of Washington Identified as Possible Sources of Toxic Releases to Water Sorted bySIC Code

Industrial Facilities in KPS Counties	SIC Code	Industrial Facilities in the Rest of the State of Washington	SIC Code
Nonwoven fabrics	2297	Nonwoven fabrics	2297
Hardwood and softwood lumber, rough & dressed	2421 & 2426	Millwork	2431
Rough & dressed lumber-treated, not edged	2491	Softwood plywood products	2436
Caulking compounds & sealants	2891	Hardboard products	2493
Structural shapes, sheet piling & concrete reinforcing bars	3312 & 3449	Solvent and water type paints	2851
Steel nails, spikes, brads, and staples	3315	Nonferrous wire and cable, including optical cable	3356 & 3357
Noncurrent-carrying devices	3644	Other insulated or covered wire and cable nec	3356 & 3357
		Plumbing fittings and brass goods	3432

water each year. There are 10 other such facilities in the Puget Sound region with reported annual toxic releases to water ranging from 14,000 to 530,000 pounds each. The total toxic releases to water in 1999 from all 10 facilities were almost 2.5 million pounds.

One manufacturer of fabrics was found in Pierce County. It is listed under SIC code 2295 which is a manufacturer of coated textiles. Since the SIC code is not 2297, no follow-up investigation was undertaken to determine whether or not this facility is producing building-related products. However, the TRI reports show that this facility reported zero toxic releases to water in 1999. (TRI reported indicated toxic releases to air and off-site transfers.)

No toxic releases to water from millwork (SIC 2431) or wood product (e.g., plywood, SIC 2436) facilities were documented. Some industrial facilities listed as manufacturing wood products report toxic releases to water but these are from combined wood and paper manufacturing operations. Almost all the toxic releases to water are from the paper manufacturing division of the facility. (This fact has been verified by phone conversations with personnel from one of the facilities.)

No manufacturers of paints (SIC 2851) or caulking compounds (SIC 2891) with reported toxic releases to water were found in the entire state of Washington.

For steel mills (SIC 3312 and 3449), the largest facility in the region transfers its solid waste toxic inventory of various metal compounds out of state. The total transfer is about 4.7 million pounds in 1999. A small steel foundry in Pierce County had toxic inventory of various metal compounds of about 500 pounds in 1999. However, follow-up investigation revealed that this facility does not manufacture products for the buildings.

One manufacturer of metal tube and wire products (SIC 3356 and 3357) was found in the state of Washington. Further inquiry revealed that it does not produce building related products.

No manufacturers of electric equipment (SIC 3644) with reported toxic releases to water were found in the entire state of Washington.

In general, compared to other industries such as paper manufacturing, building related industrial toxic releases to water in 1999 were negligible. This is true for both the three county region and the rest of the State of Washington.

Table A4.5.1.1: Industry Groups in KPS Counties and the State of Washington Identified as Possible Sources of Toxic Releases to Water Sorted bySIC Code

Facility	County	Emission	Amount (lbs)
Cascade Pole and Lumber	Pierce	Creosotes	10
Allweather Wood Treaters	Clark	Chromium Compounds	12
		Arsenic	10
		Copper	7
Exterior Wood, Inc	Clark	Chromium Compounds	12
		Arsenic	12
		Copper Compounds	7

A4.5.2 Toxic Releases to Land/Underground

Table A4.5.2 below lists the industry groups that were identified in the BaselineGreen™ analysis as sources of toxic releases to land/underground in the King, Pierce, and Snohomish (KPS) three county region and in the rest of the state of Washington. As with the industry groups identified as sources of toxic releases to water, the industry groups listed in this table were the ones that were selected for further investigation because they are the "first tier" items, i.e., upstream industrial inputs to all three building types. This detailed investigation included a review of TRI reports and, in some cases, calls to facility personnel to verify information.

The investigation revealed no direct upstream burdens associated with toxic releases to land for the building related industry groups listed above.

No manufacturers of nonwoven fabrics with reported toxic releases to land were found in the entire state of Washington.

Three facilities manufacturing treated lumber were found in the KPS three county region. None reported any toxic releases to land.

No manufacturers of caulking compounds with reported toxic releases to land were found in the entire state of Washington.

No manufacturers of ceramic tile with reported toxic releases to land were found in the entire state of Washington.

One manufacturer of wire products was found in the state of Washington. It is unclear whether or not it is a building product. However, zero toxic releases to land were reported in 1999.

Refuse systems consistently appear as a high priority item in the KPS three county region. Refuse systems are defined in the SIC index as primarily solid waste disposal in landfills, hazardous waste disposal, and incineration operations. Note that this is upstream, or supply chain, solid waste disposal, not construction solid waste or building post-use (demolition) solid waste. This is an indication that the solid waste generated by the upstream manufacturing of building materials and products is a high priority concern relative to toxic releases to land.

In general, with the exception of refuse, building related industrial toxic releases to land in 1999 were zero. This is true for both the three county region and the rest of the State of Washington.

Table A4.5.2: Industry Groups in KPS Counties and the State of Washington Identified as Possible Sources of Toxic Releases to Land Sorted by SIC Code

Industrial Facilities in KPS Counties	SIC Code	Industrial Facilities in the Rest in the Rest of the State of Washington	SIC Code
Nonwoven fabrics	2297	Nonwoven fabrics	2297
Rough & dressed lumber-treated, not edged	2491	Rough & dressed lumber-treated, not edged	2491
Caulking compounds & sealants	2891	Caulking compounds & sealants	2891
Ceramic wall & floor tile	3253	Ceramic wall & floor tile	3253
Ready-mixed concrete	3273	Ready-mixed concrete	3273
Refuse systems	4923	Nonferrous wire and cable, including optical cable	3356 & 3357

A4.5.3 Toxic Releases to Air

Table A4.5.3 below lists the industry groups that were identified in the BaselineGreen™ analysis as sources of toxic releases to air in the King, Pierce, and Snohomish (KPS) three county region and in the rest of the state of Washington. As with the industry groups identified as sources of toxic releases to water, the industry groups listed in this table were the ones that were singled out for further investigation because they are the "first tier" items, i.e., upstream industrial inputs to all three building types. This detailed investigation included a review of TRI reports and, in some cases, calls to facility personnel to verify information.

Toxic releases to air from building related wood product industries (SIC codes 2421, 2426, 2431, and 2436) located in the KPS three county region appear to be quite substantial. One millwork facility in King County reported 359,000 pounds of toxic releases to air in 1999 (the highest amount for all reporting facilities in King County). Six other wood product facilities in the three county region reported toxic releases to air totaling more than 137,000 pounds in 1999. In the rest of the state of Washington, reported toxic releases to air from building related wood product industries totaled more than 108,000 pounds in 1999.

Again, to put building related industries in perspective with all other industries, it is worthwhile to examine the toxic releases to air of the paper industry. A single paper pulp plant located in western Washington releases more than 2.5 million pounds of toxic releases to air each year. There are 10 other such facilities in the Puget Sound region with reported annual toxic releases to air ranging from 32,000 to over 1.4 million pounds each. The total toxic releases to air in 1999 from all 10 facilities were almost 7.5 million pounds. As a percentage of the paper industry, building related wood product industries accounted for about 8% of toxic releases to air in 1999.

Total toxic releases to air for the top one hundred reporting industrial facilities in the entire state of Washington were almost 19.8 million pounds in 1999. As a percentage of total statewide toxic releases to air, building related wood product industries accounted for only 3% of the total in 1999.

Eight manufacturers of paints (SIC 2851) located in the three county region reported toxic

Table A4.5.3: Industry Groups in KPS Counties and the State of Washington Identified as Possible Sources of Toxic Releases to Air Sorted by SIC Code

Industrial Facilities in KPS Counties	SIC Code	Industrial Facilities in the Rest of the State of Washington	SIC Code
Hardwood and softwood lumber, rough & dressed	2421 & 2426	Hardwood and softwood lumber, rough & dressed	2421 & 2426
Millwork	2431	Millwork	2431
Wood kitchen cabinets	2431	Wood kitchen cabinets	2431
Wood partitions and fixtures, nsk	2431	Veneer and plywood	2436
Softwood plywood products	2436	Softwood plywood products	2436
Hardboard products	2493	Rough & dressed lumber-treated	2491
Miscellaneous wood products	2499	Wood preserving	2491
Solvent and water type paints	2851	Solvent and water type paints	2851
Ready-mixed concrete	3273	Caulking compounds & sealants	2891
Brick & structural clay tile	3297	Ceramic wall & floor tile	3253
		Ready-mixed concrete	3273
		Brick & structural clay tile	3297
		Nonferrous wire and cable, including optical cable	3356 & 3357
		Residential metal doors and frames	3442
		Plumbing fittings and brass goods	3432

releases to air of about 97,000 pounds in 1999. As a percentage of total statewide toxic releases to air, paint industries accounted for less than 0.5% of the total in 1999.

No manufacturers of caulking compounds, adhesives, and sealants (SIC code 2891) with reported toxic releases to air were found in the entire state of Washington.

Toxic releases to air associated with the manufacture of ready-mixed concrete (SIC code 3273) are discussed in detail in Section A4.5.4 of this report.

Two brick manufacturing facilities (SIC code 3251) were identified in the state of Washington. One in the KPS three county region reported toxic air releases of over 52,000 pounds in 1999, down from over 67,000 pounds in 1996. (The sole toxic air release reported was hydrofluoric acid.) The one additional brick plant located in the rest of the state of Washington reported toxic releases to air of over 42,000 pounds in 1999. The combined total of 94,000 pounds is less than 0.5% of the statewide total.

No manufacturers of ceramic tile (SIC code 3253) with reported toxic releases to air were found in the entire state of Washington.

One manufacturer of metal tube and wire products was found in the state of Washington. Further inquiry revealed that it does not produce building related products.

Primary metal industries (SIC major group 33) account for almost all toxic releases to air in the state of Washington (especially aluminum industries). It is unclear, however, which of the facilities that report toxic releases to air actually manufacture building related products. Many aluminum manufacturing facilities, for example, produce parts and components for the aircraft industry. Further follow-up investigation is needed to determine which facilities are making building related products.

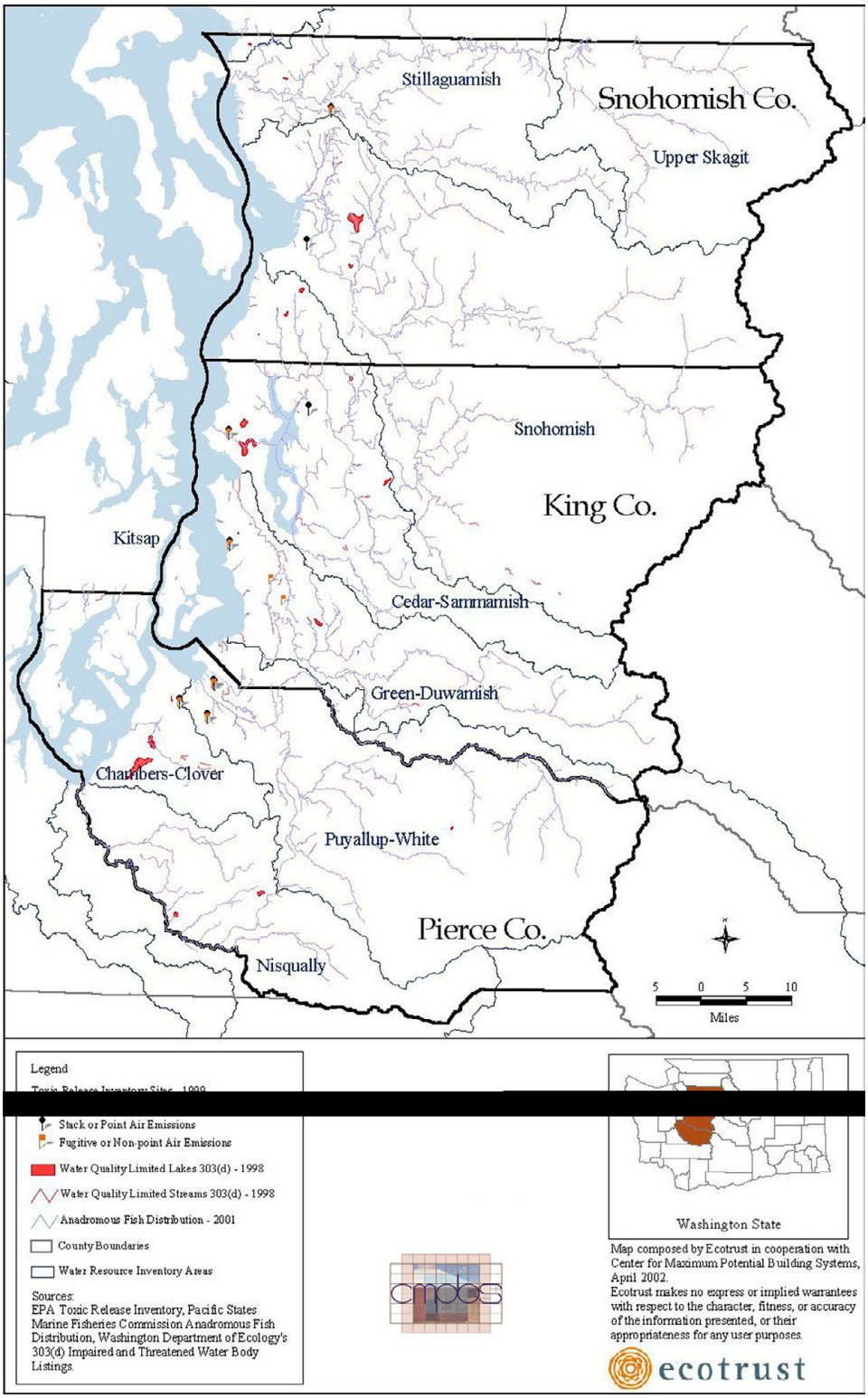
One pipe and pipe fittings manufacturing facility (SIC code 3432) was identified in the KPS three county region. It is located in King County and reported toxic air releases of over 49,000 pounds in 1999.

No manufacturers of residential metal doors and frames (SIC code 3442) with reported toxic releases to air were found in the entire state of Washington.

Several other facilities manufacturing fabricated metal products (SIC major group 34) are located in the three county region and in the rest of the state of Washington. Similar to primary metal industries, it is uncertain how many of these facilities manufacture building related products. Further follow-up investigation (e.g., calls to each individual facility) is needed and was not undertaken for this report. This would be an important step to take in an analysis of office and commercial buildings (see 2nd tier of Table A4.4.3).

Although not included in the table above, the facility with the highest level of toxic releases to air reported in 1999 was one that manufactured mineral wool products (SIC code 2297). This industry group has been identified as a high priority item for residential buildings 3rd tier, Table A4.4.3). The facility, which is located in the three county region, reported over 71,000 pounds of toxic releases to air in 1999.

Figure A4.5.3: Building Related Industries with Toxic Releases to Air in the Tri-County Region



In general, compared to other industries, building related industrial toxic releases to air in 1999 were small. Including the mineral wool manufacturing facility mentioned above, the percentage of total statewide toxic releases to air that can be attributed to building related industries is less than 5% of the total.

Building related toxic release inventory sites in the three county region reporting discharges to air are shown in Figure A4.5.3.

A4.5.4 Air Pollution

Table A4.5.4 below lists the industry groups that were identified in the BaselineGreen™ analysis as sources of air pollution in the King, Pierce, and Snohomish (KPS) three county region and in the rest of the state of Washington. As with the industry groups identified as sources of toxic releases, the industry groups listed in this table were the ones that were selected for further investigation because they are the "first tier" items, i.e., upstream industrial inputs to all three building types. This detailed investigation included a review of criteria air pollutant reports and, in some cases, calls to facility personnel to verify information.

The major air pollutant associated with wood product industries (SIC codes 2421, 2426, 2431, 2436, and 2499) is typically VOC emissions. VOC emissions from wood product industries located in the KPS three county region appear to be minor. One millwork facility in the three county region reported 158 tons of VOC emissions in 1999. Compared to almost 950 tons of VOC emissions from one paper mill, this amount seems relatively small.

In the rest of the state of Washington, VOC emissions from 19 wood product industries and one steel product facility totaled about 965 tons in 1999. VOC emissions for the top twenty-five reporting industrial facilities in the entire state of Washington were more than 11,250 tons in 1999. As a percentage of total statewide VOC emissions, building related wood product industries accounted for only 9% of the total in 1999.

One sawmill facility in King County reported 10 tons of sulphur dioxide emissions in 1999. Compared to over 550 tons from a cement plant (see below) and almost 88,000 tons from a power plant, this amount seems negligible.

Table A4.5.4: Industry Groups in KPS Counties and the State of Washington Identified as Sources of Criteria Air Pollutants Sorted by SIC Code

Industrial Facilities in KPS Counties	SIC Code	Industrial Facilities in the Rest of the State of Washington	SIC Code
Sawmills and planning mills	2421	Sawmills and planning mills	2421
Hardwood, dimension and flooring	2421 & 2426	Hardwood, dimension and flooring	2421 & 2426
Millwork	2431	Millwork	2431
Wood kitchen cabinets	2431	Wood kitchen cabinets	2431
Veneer and plywood	2436	Veneer and plywood	2436
Wood products, nec	2499	Softwood plywood	2436
Adhesives and sealants	2891	Wood preserving	2491
Glass and glass products	3211 & 3231	Wood products, nec	2499
Cement, hydraulic	3241	Solvent and water type paints	2851
Ready-mixed concrete	3273	Cement, hydraulic	3241
Gypsum building materials	3275	Ready-mixed concrete	3273
Structural shapes, sheet piling, concrete reinforcing bars	3312, 3341	Gypsum building materials	3275
		Nonferrous wire and cable, including optical cable	3356 & 3357

No manufacturers of adhesives and sealants (SIC code 2891) with reported air pollutant emissions were found in the entire state of Washington.

Emissions associated with the manufacture of cement (SIC code 3241) account for a substantial portion of air pollutant emissions in the KPS three county region but only a small portion of air pollutants in the rest of the state of Washington. Two cement plants and one lime facility in the KPS three county region account for the following emissions in the region:

- 29% of PM-10
- 19% of PM-2.5
- 13% of carbon monoxide
- 45% nitrogen oxide
- 23% sulphur dioxide.

One brick manufacturing facility (SIC code 3251) was identified in the KPS three county region. It is located in King County and reported relatively small amounts of air pollutant releases in 1999.

No manufacturers of glass building products (SIC codes 3211 and 3231) with reported air pollution releases were found in the entire state of Washington. (There are some glass container manufacturers, however.)

One gypsum manufacturing facility (SIC code 3275) was identified in the KPS three county region. It is located in Pierce County and reported relatively small amounts of air pollutant releases in 1999.

One steel manufacturing facility (SIC code 33) was identified in the KPS three county region. It is located in King County and reported moderate amounts of air pollutant releases in 1999.

In general, with one exception, building related industrial air pollutant releases in 1999 were small. That exception is the cement industry which accounts for a fairly large share of all types of criteria air pollutant emissions in the three county region.

A4.5.5 Greenhouse Gases

Table A4.5.5 below lists the industry groups that were identified in the BaselineGreen™ analysis as sources of greenhouse gases in the King, Pierce, and Snohomish (KPS) three county region and in the rest of the state of Washington. As with the industry groups identified as sources of toxic releases, the industry groups listed in this table were the ones that were selected for further investigation because they are the "first tier" items, i.e., upstream industrial inputs to all three building types.

Table A4.5.5: Industry Groups in KPS Counties and the State of Washington Identified as Sources of Greenhouse Gases Sorted by SIC Code

Industrial Facilities in KPS Counties	SIC Code	Industrial Facilities in the Rest of the State of Washington	SIC Code
Millwork	2431	Millwork	2431
Cement, hydraulic	3241	Solvent and water type paints	2851
Ready-mixed concrete	3273	Cement, hydraulic	3241
Fabricated structural iron, steel and aluminum	3441	Ready-mixed concrete	3273
		Fabricated structural metal	3441

Greenhouse gas emissions are not required to be reported to state or U.S. regulatory agencies. They can be estimated for a given year, however, if both annual energy consumption and type of fuel used are known for a particular manufacturing facility. In some cases, annual product output by weight can also be an indicator of greenhouse gas emissions.

Greenhouse gas emissions for millwork facilities (SIC code 2431) and paint manufacturers (SIC code 2851) could not be verified. Information regarding both annual production output and annual energy use could not be obtained within the timetable allowed for this report. Further investigation of each millwork and paint manufacturing facility in the three county region and the rest of the state of Washington would have to be undertaken to estimate total greenhouse gas emissions for these two industry groups.

Emissions of CO2 associated with the manufacture of cement (SIC code 3241) account for a substantial portion of greenhouse gas emissions in the KPS three county region and possibly a large portion of GHGs in the rest of the state of Washington. Two cement plants in the KPS three county region account for approximately 1 million tons of CO2 emissions per year. This is the combined total for fossil fuel energy generated electricity use, on site fuel combustion, and chemical reactions in processing lime. The two cement manufacturing facilities are presently the 5th and 6th largest users of electricity provided by Seattle City Light.

By comparison, emissions of CO2 associated with the manufacture of fabricated steel products (SIC code 3441) accounts for a smaller portion of greenhouse gas emissions in the KPS three county region. The CO2 emission total for the one steel product manufacturer in the region is approximately 53,000 tons per year. This is the total for fossil fuel energy generated electric power. This steel manufacturing facility is the largest user of electricity provided by Seattle City Light.

A4.6 Discrepancies Between BaselineGreen™ Findings and Review of Toxic Release Inventory Data for Industrial Facilities

The BaselineGreen™ approach to regional economic modeling-based Life Cycle Assessment (LCA) follows standard practice in both LCA and economic input/output modeling, which is to model each unit process and/or sector using data reflecting the average process or factory in that process class or sector. Thus, in LCA, unit process data for coal-fired boilers will generally reflect the average coal inputs and emissions outputs from such boilers, per unit of product (e.g., steam) delivered. This average approach is used both to protect proprietary data of any one plant, and because the data are often used to model numerous instances of a same process type within a supply chain.

The ingredients of an LCA model, whether process-based or economic input/output-based (as in our example) are twofold:

a) production function data specifying the inputs required per unit of product output;
b) emissions coefficients specifying the quantity of each pollutant released to the environment per unit of product output.

The data for (a) comes directly from the national input/output tables. This production

function data is then combined with county-level information on the share of each product's local usage that is supplied by local production.

The data for (b) comes from the national Toxic Release Inventory (TRI) latest data year 1999. We calculate national average emissions coefficients by using the total TRI releases to each media for each sector and dividing that amount by the total value of product shipments from each sector. This yields national average, sector-specific emissions coefficients in terms of pounds of TRI per dollar amount of product shipped. Aggregation of both production and release data to the national level helps cancel out reporting errors and stochastic variability in each data set. County-level emissions coefficients would be very resource-intensive to develop and would also lack these error-canceling benefits.

The national average emissions factors may differ from local emissions coefficients for a variety of reasons. If local plants are small enough, or if their use of TRI chemicals is low enough, it may fall under TRI reporting thresholds. Also, of course every plant is likely to differ somewhat from the national average in terms of emissions per unit of output.

For reasons such as this, our model predicts some nonzero toxic releases even from some sectors for which the EPA does not show toxic releases for 1999. Still, as our model results show, the bulk of the total cradle-to-gate emissions come from plants out of the region, whose locations are scattered throughout the U.S. and for which national average emissions coefficients are a wise choice.

A5.0 Conclusions and Recommendations

Earlier in this report, upstream building-related environmental burdens affecting salmon habitat were prioritized from most direct to least direct impact as follows:

- Most direct: Toxic releases to water,
- Toxic releases to land/underground,
- Toxic releases to air,
- Criteria air pollutants,
- Least direct: Greenhouse gas emissions.

For each of these five burdens, the BaselineGreen™ analysis reported the following results:

- Toxic releases to water: Compared to other industries such as paper manufacturing, building related industrial toxic releases to water reported in 1999 were less than 1 percent. This is true for both the three county region and the rest of the State of Washington. These releases to water were made by three wood treatment facilities, one of which is located in the KPS three county region.

- Toxic releases to land: With the exception of refuse, building related industrial toxic releases to land reported in 1999 were zero. This is true for both the three county region and the rest of the State of Washington.

- Toxic releases to air: Compared to other industries, building related industrial toxic releases to air in 1999 were small. The percentage of statewide reported toxic releases to air that can be attributed to building related industries is less than 5% of the total.

- Criteria air pollutants: With the exception of cement building related industrial criteria air pollutant releases in 1999 were small. The cement industry accounts for a fairly large share of all types of criteria air pollutant emissions in the three county region.

- Greenhouse gas emissions: Emissions of CO2 associated with the manufacture of cement (SIC code 3241) and fabricated steel products (SIC code 3441) account for a substantial portion of greenhouse gas emissions in the KPS three county region and possibly a large portion of GHGs in the rest of the state of Washington. Two cement plants and one lime facility in the KPS three county region account for approximately 1.4 million tons of CO2 emissions per year. The CO2 emission total for the one steel product manufacturer in the region is about 250,000 tons per year.

In summary, the BaselineGreen™ analysis revealed a small direct link between upstream environmental burdens associated with the manufacture of building materials and products and environmental factors detrimental to salmon habitat. For the most direct environmental burden, toxic releases to water, building related industries accounted for less than 1 percent of all toxic releases to water for the State of Washington and the KPS three county region reported in 1999. For the second most direct burden, toxic releases to land, no building industries reported in 1999.

It appears that, as the links between upstream environmental burdens and salmon habitat become more and more indirect, the role of building related industries becomes more significant. Several building related industries reported toxic releases to air, for example. However, the building industry share of annual releases is quite small accounting for only about 5% of all toxic air releases in 1999.

Similarly, for criteria air pollutants, several building related industries reported emissions, but the total was small compared to other industries. The one exception in the three county region is the cement industry which accounts for a large share of local air pollutants.

As mentioned earlier, the impact of criteria air pollutants on salmon habitat is indirect. The pollutants must return to land and water via atmospheric deposition. Airshed patterns and monitoring of several sites in western Washington indicate that the area is not susceptible to atmospheric deposition. Additionally, air pollution associated with a building may be much greater during use stage due to energy use over a building lifetime.

Related to global climate change, also an indirect factor affecting salmon habitat, the effect of upstream building related industrial greenhouse gas emissions is similar to that of air pollutants. Again the one exception is the cement industry which likely accounts for a large share of local upstream greenhouse gas emissions. Upstream GHGs however, are quite small compared to energy consumption during the use stage (occupancy) of a building over its lifetime and to other sources of GHGs (e.g., the transportation sector).

Given the above results and conclusions, there are several caveats however:

1. The Toxic Release Inventory (TRI) data used for BaselineGreen™ relies on reports submitted by industries. It is possible that some releases may be un- or under-reported.
2. Establishing direct cause-effect links between specific stressors and salmon is elusive. Scores of studies and scientific reports reference the uncertainties associated with definitive declarations of what are contributing factors to salmon decline.
3. The heightened awareness of persistent bioaccumulative toxins (PBTs) as a class of chemicals may not be matched by the way in which data are currently reported.
4. While the reported toxic releases to water associated with the generic building types' bill of materials areminor, there *are* releases to air of both greenhouse gases (principally CO2) and toxic chemicals. Both of these may result in indirect impacts on salmon: in the case of CO2 releases, the consequent climate change is associated with rising global temperatures; in the case of toxic releases to air, these chemicals disperse and may eventually fall to the ground, impacting land and water quality. Because of the more distributive nature of air releases than water releases, the point source relative to proximity to habitat is of diminished importance, particularly when these releases are PBTs.

These results point to other possible building related activities as having a more significant impact on salmon habitats in the region. Some of these are briefly discussed below.

Upstream in the life cycle of buildings, impacts from the extraction of resources, such as erosion and sedimentation from logging and mining, can be sizeable. BaselineGreen™ is not structured to inventory and map regional erosion and sedimentation related to

upstream building activities. Additionally, there are supply chain activities that may have environmental impacts other than the three environmental burden indicators mentioned above. Besides erosion and sedimentation, those impacts include loss of vegetation, other changes in land cover, and fertilizer, pesticide, and herbicide use.

Other impacts occur during the use phase of buildings. These include power sources for electric generation. Perhaps the most important step in developing salmon-friendly buildings is the generation of salmon-friendly power. The purchase of salmon friendly power ideally decreases reliance on dams and diversions that produce power from non-fossil fuel sources but have adversely affected salmon habitat in the process.

On an urban development scale, topics such as impervious cover, dredging, filling, and channelization of streams, landscape and household fertilizer use, and transportation related issues might be significant concerns. As mentioned earlier, these are beyond the scope of work of this report.

Given these conclusions, the following recommendations can be made as salmon-friendly policies and practices. These recommendations follow the format outlined in LEED version 2.0, "Materials and Resources" credits. However, BaselineGreen™ will recommend practices different from LEED in some cases, because its methodology is based on a life cycle assessment (LCA) approach to assessing environmental impacts. These differences will be discussed under the appropriate LEED Credits below.

Promote Building Reuse (LEED Materials and Resources Credit 1)
Reusing large portions of existing structures reduces the need for newly manufactured building materials and products. As described in the three BaselineGreen™ analyses reviewed in this report, every manufactured building material and product is associated with some form of upstream environmental burden. Reusing major portions of existing buildings, such as the structure or shell, can minimize or even avoid some of these burdens.

Promote Resource Reuse (LEED Materials and Resources Credit 3)
Specifying salvaged or refurbished materials can also reduce the need for newly manufactured building materials and products. Similar to building reuse, using recovered materials and products from existing buildings, such as beams, columns, flooring, doors, and windows, can minimize or even avoid upstream environmental burdens.

Promote Recycled Content Materials and Products (LEED Materials and Resources Credit 4)
Recycled content materials and products reduce negative environmental impacts associated with the extraction of new raw materials. Processing of virgin materials consumes both energy and resources and is usually associated with some form of upstream environmental burden.

One major product to examine under this credit is Portland cement. The feasibility of using cement substitutes such as fly ash in the making of concrete products should be investigated. Although only indirectly affecting salmon habitat, cement manufacture is responsible for a huge portion of local and regional air pollution and greenhouse gas emission burdens. These burdens can be greatly reduced with cement substitutes.

Other major products to examine under this credit are structural steel and fabricated steel products. These input items consistently appear as high priorities in terms of upstream environmental burdens for average U.S. construction of all three building types examined in this report. These input items are responsible for a large portion of local and regional air pollution and greenhouse gas emission burdens. These burdens can be greatly reduced by replacing new raw materials with recycled materials.

An LCA approach to assessing environmental burdens reveals that many industrial processes produce usable by-products that are not technically post-industrial or post-consumer recyclables. They are used as processing agents or are physically different than the material or product being manufactured. Fly ash and slag are examples. Under the topic "recycled content materials and products" therefore, BaselineGreen™ recommends the inclusion of by-product materials.

Promote the Use of Local/Regional Materials and Products (LEED Materials and Resources Credit 5)

LEED and BaselineGreen™ differ on their approaches to and recommendations for this topic. LEED recommends using local and regional products "across the board" as a means of reducing upstream environmental impact associated with the transport of goods and materials. However, an LCA approach reveals that there may exist much more harmful upstream burdens during the manufacturing stage of a material or product than during the transport stage. One should not assume outright that local and regional manufacturers have zero environmental burdens associated with their facility. In fact, the BaselineGreen™ analysis of average construction in the U.S. has informed us to initially assume otherwise. Thus, using local and regional materials can be recommended only if some sort of LCA approach is incorporated into the specification process.

Although the three BaselineGreen™ analyses in this report indicated that, for average construction in the entire U.S., many building related materials and products are associated with upstream toxic releases, air pollution, and greenhouse gas emissions, a review of the data suggests that fortunately, local and regional industries in Seattle and the State of Washington have become "cleaner and greener" than the U.S. average. There were no documented toxic releases to water or land from local and statewide building related industries in 1999 and toxic releases to air that can be attributed to building related industries is less than 5% of the statewide total. Therefore, specifying materials and products from local and / or regional manufacturers will not necessarily result in an increase in associated upstream environmental burdens at the local and regional scale. With the exception of cement and fabricated steel products, the same can be said for upstream air pollutant and greenhouse gas emissions.

The above statement is made with caution. Many local and regional building related industries did report toxic releases to water, land, and air in previous years. Constant monitoring of upstream manufacturing impacts must be a part of any "buy local" program. The BaselineGreen™ analyses have indicated that careful attention should be paid when specifying the building materials and products listed below. These are products that consistently appear as "high priority" inputs in average U.S. construction but local and regional manufacturers were found to be "cleaner and greener."

- Rough lumber products and processed lumber products such as plywood,

waferboard, millwork, and wood cabinets (SIC codes 2421, 2426, 2431, 2436, 2491, 2493).

- Cement (SIC code 3241).
- Structural steel and fabricated steel products (SIC codes 3441, 3449).
- Paints (SIC code 2851).

Cement and steel have been discussed above under Materials and Resources Credit 4. Lumber is discussed below under Materials and Resources Credit 7.) Although paint products are addressed in LEED version 2 under Indoor Environmental Quality Credits, that topic does not address the concerns raised by BaselineGreen™. The upstream impacts of paint manufacture are better addressed as a "materials and resources" topic. The recommendation regarding paints is to comply with standards for chemical content set by Green Seal third party certification guidelines.

Promote the Use of Certified Wood Products (LEED Materials and Resources Credit7)
As mentioned above, rough and finish wood products consistently appear as "high priority" inputs in average U.S. construction. However, with the exception of criteria air pollutant emissions, local and regional manufacturers were found to be "cleaner and greener" than the U.S. average. Although only indirectly affecting salmon habitat, the processing of finished wood products such as millwork and plywood is responsible for a huge portion of local and regional air pollution and greenhouse gas emission burdens. Specifying products certified by an independent third party program is one step that can be taken to begin to minimize the environmental impact of wood product manufacturing in the region.

Promote the Use of Naturally Resistant Lumber and Alternatives to CCA Treatment
This recommendation is in response to the fact that all known building related toxic releases to water in the three county region and Washington State are from wood treatment facilities that either use creosote or the chromated copper arsenic (CCA) process. Naturally resistant lumber (which should, of course, come from a sustainably managed forest), such as redwood or cedar is pest resistance without chemical treatment. Alternatives to the CCA process include ACQ (Ammoniacal Copper Quaternary), CBA (Copper Boron Azole), boron, and plastic wood made from recycled polyethylene and wood or other cellulose fibers.

Appendix B:

Wingspread Statement on the Precautionary Principle

This statement was drafted and finalized at a conference at the Wingspread Conference Center, Racine, Wisconsin, which took place 23-25 January 1998. The 32 authors of the statement are listed beneath the statement.

The release and use of toxic substances, resource exploitation, and physical alterations of the environment have had substantial unintended consequences on human health and the environment. Some of these concerns are high rates of learning deficiencies, asthma, cancer, birth defects and species extinctions; along with global climate change, stratospheric ozone depletion; and worldwide contamination with toxic substances and nuclear materials.

We believe existing environmental regulations and other decisions, particularly those based on risk assessment, have failed to adequately protect human health and the environment, as well as the larger system of which humans are but a part.

We believe there is compelling evidence that damage to humans and the worldwide environment, is of such magnitude and seriousness that new principles for conducting human activities are necessary.

While we realize that human activities may involve hazards, people must proceed more carefully than has been the case in recent history. Corporations, government entities, organizations, communities, scientists and other individuals must adopt a precautionary approach to all human endeavors.

Therefore it is necessary to implement the Precautionary Principle: Where an activity raises threats of harm to the environment or human health, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically.

In this context the proponent of an activity, rather than the public bears the burden of proof.

The process of applying the Precautionary Principle must be open, informed and democratic, and must include potentially affected parties. It must also involve an examination of the full range of alternatives, including no action.

Wingspread conference participants:

(Affiliations noted for identification purposes only.)

* Dr. Nicholas Ashford, Massachusetts Institute of Technology
* Katherine Barrett, Univ. of British Columbia
* Anita Bernstein, Chicago-Kent College of Law
* Dr. Robert Costanza, University of Maryland
* Pat Costner, Greenpeace
* Dr. Carl Cranor, Univ. of California, Riverside
* Dr. Peter deFur, Virginia Commonwealth Univ. Gordon Durnil, attorney
* Dr. Kenneth Geiser, Toxics Use Reduction Institute, Univ. of Mass., Lowell
* Dr. Andrew Jordan, Centre for Social and Economic Research on the Global Environment, Univ. Of East Anglia, United Kingdom
* Andrew King, United Steelworkers of America, Canadian Office, Toronto, Canada
* Dr. Frederick Kirschenmann, farmer
* Stephen Lester, Center for Health, Environment and Justice
* Sue Maret, Union Institute
* Dr. Michael M'Gonigle, University of Victoria, British Columbia, Canada
* Dr. Peter Montague, Environmental Research Foundation
* Dr. John Peterson Myers, W. Alton Jones Foundation
* Dr. Mary O'Brien, environmental consultant
* Dr. David Ozonoff, Boston University
* Carolyn Raffensperger, Science and Environmental Health Network
* Dr. Philip Regal, University of Minnesota
* Hon. Pamela Resor, Massachusetts House of Representatives
* Florence Robinson, Louisiana Environmental Network
* Dr. Ted Schettler, Physicians for Social Responsibility
* Ted Smith, Silicon Valley Toxics Coalition
* Dr. Klaus-Richard Sperling, Alfred-Wegener- Institut, Hamburg, Germany
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